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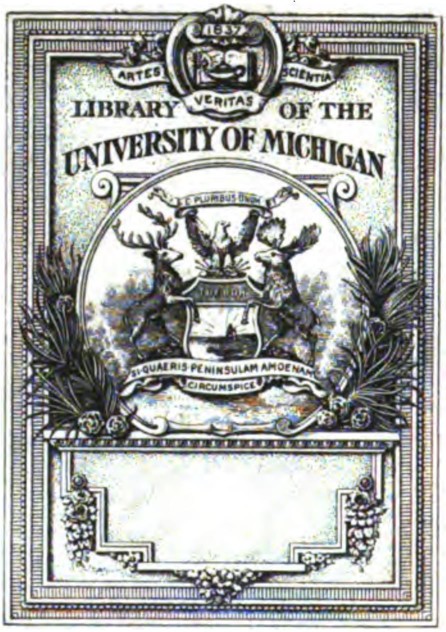
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THE COMPOSITION

OF THE

URINE.

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THE COMPOSITION

OF THE

URINE,

IN

HEALTH AND DISEASE, AND UNDER THE ACTION OF REMEDIES.

BY

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TO

SIR JAMES CLARK, BART., M.D., F.R.S.,

PHYSICIAN IN ORDINARY TO THE QUEEN AND TO HIS ROYAL HIGHNESS THE PRINCE CONSORT.

MY DEAR SIR JAMES,

Had I sought for a reason to dedicate this work to you, I might have found it at once in the consideration of your public reputation, or of your known opinions on the importance of teaching Medical Chemistry. But I prefer taking another ground, and asking you to accept this Dedication as a slight acknowledgment of my personal obligation to you for acts of friendship and kindness which it will be impossible for me ever to forget.

Believe me,
My dear SIR JAMES,
Faithfully yours,
E. A. PARKES.

PREFACE.

I HAVE attempted, in this work, to give an abstract (necessarily extremely condensed, but I hope accurate) of the very numerous observations on the 'Urine of Man' which have been made of late years. It seemed to be very desirable to compress, if possible, into some narrow compass the records of researches of great interest, but yet so elaborate in their details, and so scattered in different publications, as to be almost inaccessible to men engaged in active professional work. To anything like a full account I cannot lay claim, but I hope I have succeeded in presenting a readable book for those who wish merely to know the latest observations on this subject, and in furnishing to those engaged in similar original inquiries some assistance in the way of references. I have given the references carefully, not from display or pedantry, but because I am quite convinced that, in the present state of this difficult inquiry, every statement should be easily traced to its author, so as, if necessary, to be properly verified.

The title of the book expresses its exact nature; it is a mere enumeration of the alterations in the urinary constituents under various circumstances. I have not entered into the chemical history of these constituents, nor into the mode of determining their amounts. Works on chemistry deal better with the first subject, and the technical treatises of Neubauer and Thudichum have, for the time, exhausted the second.

Nor have I given illustrations of urinary sediments; for the treatises of Golding Bird, George Johnson, Hassall, Beale, Basham, and others, are in the hands of all; and so many beautiful plates have been lately published by Funke, Verdeil, Beale, Hassall, Basham, and Thudichum, that to insert plates in this book is really unnecessary.

The present volume was intended only as the first of a series. In the second, I proposed to enumerate the alterations in the excretions from the skin, the lungs, and the intestines; and in a third volume, I hoped, if I thought myself competent for the task, to consider the nature of the tissue-changes which lead to alterations in the excretions. Whether or not I shall ever be able to complete this design is uncertain; if not, I hope the present volume may be of some little aid to a future writer.

The plan of this work will be seen at once, by a reference to the table of contents. In the first book, the urine in health is considered; and in the second, the urine of disease. Each book is preceded by an introduction, in which, in the one case, the normal constituents of healthy urine, and, in the other, the abnormal constituents of unhealthy urine, are enumerated.

In choosing a plan for arranging the facts, two modes are open. We may either follow Professor Julius Vogel, and under the head of each urinary ingredient place all the changes which occur in it, or exactly reversing this order, we may pass in review all the possible physiological and pathological conditions, and under each head discuss each urinary ingredient. I have adopted the last plan, as equally philosophical, and as more useful. But whoever wishes to trace the alterations in any special ingredient has only to follow this constituent through the different headings.

Another point for consideration was the extent in which I should discuss the experiments of observers, should give their figures, and determine the reliance to be placed on them. But I soon found that it was impossible, with the range of subjects I had chosen, to do more than give the most certain facts, and what appeared to me, after full consideration, to be the most trustworthy experiments.

In citing numbers, I have been obliged to omit a great number of tables, and to content myself with the mean results; but the references will enable any one who wishes to determine the maximum and minimum amounts to do so.

Although I do not undertake, in this volume, to give an account of the excretions of the lungs, the skin, and the bowels, I have frequently noticed their variations, as, without a knowledge of them, the changes in the urine lose half their interest. When the variations in these excretions are better known, no work, on the urine alone, will ever be published, but all the excretions will be simultaneously considered. To a certain extent, I have made an attempt to do this in the present volume.

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ADDITIONS AND CORRECTIONS.

Introduction, p. 5.—Dr. L. Lehmann is, in several places, termed J. or Julius Lehmann, instead of L., or Lucius. The initials of Professor Lehmann, of Jena, are C. J.

Introduction, p. 9.—Creatin and creatinin. Since these pages were printed, a very elaborate paper, by Schottin (Archiv für Heilkunde, 1860, p. 417), has been published, which contains the results of three years' labours. Schottin considers that creatin and creatinin are chiefly products of the metamorphosis of striped muscle; he does not positively decide whether or not they pass into urea (though he evidently inclines to this belief), or whether creatinin is formed from creatin. He found, in health and in many diseases, the amount and even the presence of these bodies in the urine very inconstant; and when present, the amounts were often only microscopic. The diseases in which he found creatin and creatinin in larger quantities were divisible into two groups.

In the first group these bodies appeared in consequence, apparently, of their transformation into a higher oxidized body (urea) being hindered.

In the second group, the formation of creatin was increased from more active degeneration of the striped muscles.

1. The first group occurred in cases of morbus Brightii, and presented symptoms of uræmia; twenty-three cases are referred to, in which the amount of creatin was increased, and, in all, the increase was parallel with the uræmic symptoms. The amount of creatin in twenty-four hours is not stated very carefully, but it appears to have ranged, in different cases, from 0·3 to 1·10 grammes. In these cases creatin was also found in the blood, and in the dropsical fluids, if these were present. Schottin believes that the production of uræmia is to be attributed to a lowered and impeded metamorphosis of the tissues generally, and of the nerve-substance in particular, and to an accompanying lower grade of oxidation. He states, that the diminution of urea in morbus Brightii does not consist only in lessening of elimination through the diseased kidneys, but also "certainly in a want of transformation of lower oxidized substances into urea." Among these substances, he conjectures, creatinin may be one; and then remarks, that so strong a base as this substance remaining in the body might very well act as a poison, and decompose ammoniacal compounds. In this way, he thinks, the appearance of ammoniacal compounds, in the urine of typhus and uræmia may be accounted for.

2. While Schottin looks upon the increased amount of creatinin and creatin in uræmia as evidence merely that these substances have been retained in the blood, without undergoing the usual further metamorphosis, in the second group there is a most decided increase, owing to increased muscular metamorphosis. This occurs especially in typhus abdominalis (typhoid fever), in which disease Zenker has shown there occurs a very extensive degeneration of striped muscles. In twenty-two cases of typhoid fever, the increase in creatinin was found to begin in the second week of the disease, and to reach its highest amount in cases of recovery between the third and fourth weeks. The excretion did not always run parallel with the typhoid symptoms, and in some cases, while improvement went on, the elimination of creatinin became still greater. In many cases, the elimination of creatinin was traceable to the sixth and seventh weeks. The amount varied from 0·2 to 0·34 grammes (3 to 5 grains—an amount which is not, however, equal to that stated to occur, by Thudichum, as a physiological excretion). Schottin communicates observations on the muscles of typhoid patients, proving that the formation of creatin is really increased in these tissues.

In addition to these two causes of augmented creatin and creatinin in urine (viz., morbus Brightii and typhoid fever), Schottin relates two other cases, one of pulmonary emphysema and catarrh, and another of cancer of the stomach, in which he found 0·3 and 0·52 grammes of creatinin. In both cases there was slight albuminuria, but no decided kidney disease.

In three cases of pulmonary tubercle, one of granular liver, one of pneumonia, one of morbus Brightii without uræmic symptoms, one of "ataxie locomotrice progressive," one of lead poisoning, one of spinal paralysis, and one of chlorosis, no creatin or creatinin was found in the urine.

The objection to these observations is, that we are hardly yet acquainted with the physiological excretion of creatin. Either Schottin has placed it too low, or Thudichum too high.

Introduction, page 10, foot-note 4.—For "Scherer believes sarkin to be identical with xanthoglobulin," read "with hypoxanthin."

Introduction, Book I, page 13. — Carbonic acid, oxygen, nitrogen, in urine. Planer (Zeitsch. der Wiener Aerzte, 1859) has particularly determined the amount of CO_2 in the urine, and has also discovered that some nitrogen and a small portion of oxygen is also contained in it. While 1000 c.c. of fasting urine contained about 45 c.c. of free CO_2, in the food urine there was no less than 99·6 c.c. per mille; there was also 20 and 52 c.c. of combined CO_2 in the urine of inanition and the urine of food, respectively. Bitartrate of potash increased the CO_2 three-fold. The amounts of nitrogen and oxygen were about 8 and 0·4 c.c. per mille, respectively.

Introduction, page 13.—Hippuric acid. Wreden (quoted by Scherer, in 'Canstatt's Jahresb.,' 1860, vol. i, p. 243) found the hippuric acid in much greater quantity than has yet been noted; in larger quantity, indeed, than the phosphoric acid.

Introduction, page 32.—Ingesta and egesta. Volz (quoted by Valentin, in 'Canstatt's Jahresb.' for 1859, vol. i, p. 64, 1860) gives, from 800 weighings, the following mean quantities of ingesta and egesta, for a man weighing 56 kilogrammes, or 123 pounds avoirdupois.

The total ingesta and egesta are about $\frac{1}{20}$th of the body-weight.

	In 24 hours.	
	Grammes.	Grains.
Total Ingesta . .	2805	43173
Total Egesta . . .	2884	44528

During the period of experiment there was, therefore, a daily loss of weight.

Excretion according to weight.

	1 kilogramme excreted in 24 hours,	1 lb. excreted in 24 hours,
	Grammes.	Grains.
Urine	30·1	211·2
Insensible perspiration, skin and lungs	18·7	131·2
Fæces	2·4	16·8
Total to 1 kilogramme .	51·2	359·2

The whole body excreted in twenty-four hours—

	Grammes.	Grains.
Urine	1685·6	25,977
Insensible perspiration .	1047·2	16,137
Fæces	134·4	2,066
	2867·2[1]	44,180[1]

The mean per-centage amount of the excretion was—

Urine . . .	57 to 61 per cent.
Insensible perspiration	33 „ 38 „
Fæces . . .	4 „ 5 „

Book I, Chapter II, page 141.—The effect of arsenic. Schmidt and Stürzwage (quoted by Valentin, in 'Canstatt's Jahresb.' for 1859, vol. i, 1860) have determined that small doses of arsenious acid produce a considerable diminution of metamorphosis (20 to 40 per cent.). Both the urea and the pulmonary carbonic acid were lessened, and corresponding quantities of fat and albumen were retained in the body; so that the weight of the body increased. These experiments seem to show, that the fattening effect of arsenious acid on horses and men, of which so much has been said, is really correct.

Large doses produced irritation of the nervous centres; so that the effect on metamorphosis was, perhaps, produced by the action, in a minor degree, of this poison on the nerves.

In the blood of a horse, arsenic was found in the red corpuscles, but not in the serum.

The effect of kakodyl on the body appears, from Schmidt's observations, to be entirely attributable to the great attraction which it has for oxygen. The lungs, and not the kidneys, appear to be the chief channel of exit, although in part it emerges by the latter organs.

Book I, Chapter II, p. 149, line 13, for "tolulic acid," read "toluylic acid."

Book I, Chapter II, p. 157, line 14, for "limits of urea," read "limits of error."

Book I, Chapter II, page 167.—Elimination of quinine by the urine. Briquet is wrongly quoted, as stating that half the quinine taken as medicine passes into the urine. In point of fact, he did not determine the exact amount, but merely judged of the quantity by the abundance of the precipitate of iodide of quinine in the urine, when iodine and iodide of potassium were added to it. He found the "abundance of precipitate in the urine always proportionate to the dose;" and, although he does not deny that some may remain in the tissues for some time, he thinks this quantity must be small. He seems to deny, as far as can be gathered from his description, that any is decomposed. 'Traité Thérapeutique du Quinquina,' par P. Briquet. Paris, 1853, pp. 217—232.

Briquet also states, that if quinine passes in very large quantity in the urine, it may produce considerable irritation of the bladder, and sometimes even hæmaturia or albuminuria.

Book II, Introduction, p. 202, line 9, for "euroerythrin," read "uroerythrin."

Book II, Chapter III, p. 234, footnote, for "charges," read "changes."

Book II, Chapter III, p. 269.—Acute nervous diseases. In that peculiar affection brought on by excessive heat, direct or indirect, and which is ordinarily termed "sun-stroke," and is referred to some affection of the nervous system, an interesting observation has been made by Professor Longmore, of the Army

---

[1] There is a slight discrepancy between this number and that assigned above to the total egesta, which Valentin's abstract does not allow me to rectify.

Medical School. He has observed, that for some hours before the nervous symptoms come on there is frequent micturition, and, apparently, the quantity of water is increased, though, on this point, no accurate measurements have been made. Possibly, the condition of the nervous system may relax the kidney vessels, as appears to be the case in hysteria and epilepsy. The composition of the urine is not known.

BOOK I.

THE URINE IN HEALTH.

INTRODUCTION.

SECTION I.

ON THE AVERAGE QUANTITIES OF THE NORMAL CONSTITUENTS OF THE URINE, EXCRETED BY HEALTHY MEN, BETWEEN TWENTY AND FORTY YEARS OF AGE, IN TWENTY-FOUR HOURS.

Four methods have been, and in part are still, employed in stating the composition of the Urine.

First. In most of the older analyses, those, for example, of Simon and of his pupil Heller, the per-centage amounts of the urinary constituents are alone determined, *i.e.*, it is stated that in 100 or 1000 parts of urine there are so many parts of urea, uric acid, salts, water, &c. Such analyses give only the relative amounts of the constituents *inter se*—information of comparatively little value.

Second. In order to eliminate from the analyses the differences caused by the ever-varying amounts of water which are excreted from the kidneys, the per-centage amounts of the solid constituents of the urine are given in many analyses, and it is stated that, in 100 or 1000 parts of the dried solids of the urine, there are so many parts of urea, uric acid, salts, &c. This plan, like the former, gives only the relative amounts of the constituents *inter se*, and is, in fact, merely a more accurate method of stating the same facts.

Third. As it was soon seen that no deductions of any value could be drawn from the employment of these plans, a third method of stating the results of the analyses has been adopted, and the amounts of the urinary constituents, formed in, and excreted from, the body in a given time, have been determined. This method gives not only the relative but the absolute quantities of the constituents, and it is now in general use. The period of twenty-four hours is usually chosen (unless under special circumstances), as in this time the body passes through the entire cycle of changes caused by exercise, rest, sleep, food, day and night, &c.

Fourth. The results of the analyses are often stated not only in relation to the time during which the constituents were formed, but in relation also to the amount of weight of the body. Thus, in addition to saying that so many grains of urea or uric acid were excreted in one, twelve, or twenty-four hours, it is also often stated how many grains were furnished by each pound weight of the body in the given time.[1]

As these two last methods include all that is valuable in the other statements, they have been alone employed in the following work; and this introduction is chiefly occupied with an enumeration of the mean amounts of the urinary constituents excreted in twenty-four hours by the whole body, and by a definite amount of body weight in adult males.

In this Introduction I have collected together, from all sources, as many analyses as possible of the various urinary constituents in perfectly healthy persons, and have taken the mean results arrived at by each observer. These mean results have been, in almost all cases, derived from the investigation of many days; in a few cases only I have taken the mean of so small a number as three days. Almost always the number of days has been sufficient to give the true mean proper to the particular individual experimented upon.

In order to obtain a standard with which other analyses might be compared, I have selected the male sex, and the period of life between twenty and forty years.[2] The variations from this standard produced by sex, age, food, exercise, &c., are afterwards considered in the body of the work.

The analyses are taken from French, German, American, and English sources, as in all these countries the mode of life is sufficiently alike to allow of a comparison. The quantities are given both in French and English weights, for the convenience of the reader. The gramme is taken as 15·44 grains, and the cubic centimeter as 16·9 minims. The nation of the observer is sufficiently indicated by the name and the reference. The food was in all cases sufficient and of good quality.

1. *The Water of the Urine.*—Average amount of urine passed in twenty-four hours by healthy male adults, between twenty and forty years of age. The number of days furnishing the mean is in no case less than six, and generally many more

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[1] The excretion in a given time, according to the height of the body, is sometimes used, but at present no value attaches to these determinations.

[2] In one case the age was eighteen, and in one case a little over forty.

than this. The lowest numbers are placed at the top of the list:

NAME OF OBSERVER.	Amount in cubic centimeters.	Amount in fluid ounces (fractions omitted).
Prout	994	35
Bird	1079	38
Schirks[1]	1080	38
Hammond[2]	1131	39½
Parkes[3]	1136	40
Becquerel[4]	1267	44
Lecanu[5]	1268	44
Roberts[6]	1306	46
Schneller[7]	1326	46
Genth[8]	1335	47
Kaupp[9]	1354	47
Beneke[10]	1405	49
Neubauer[11]	1414	49
Valentin	1448	50
Kerner[12]	1491	52
Bischoff[13]	1538	54
V. Franque[14]	1556	54
Julius Vogel[15]	1635	57
Beneke (2d observation)[10] ...	1677	59
Beigel[16]	1688	59
Thudichum[17]	1832	61
Mosler[18]	1865	65
Julius Lehmann[19]	1922	67

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[1] Canstatt's Jahresb., 1857, Band i, p. 84.

[2] American Journal of Med. Sci., April, 1856.

[3] Mean of 20 days in one person.

[4] Semiotique des Urines, 1841.

[5] Journal de Pharmacie, 1839, t. xxv, p. 681.

[6] Edinburgh Medical Journal, 1860.

[7] Valentin's Report on Phys. in Canstatt's Jahr., 1855.

[8] Unters. über den Einfluss des Wassertrinkens. Wiesb., 1856, p. 68.

[9] Vierordt's Archiv for 1856, p. 555.

[10] Various papers in the Archiv für wiss. Heilkunde, and Die Wirkung des Nord-See Bades, 1855. (Mean of all the experiments on the same person.)

[11] Archiv für wiss. Heilk., Band iii, p. 63.

[12] Archiv für wiss. Heilk., Band iii, p. 627.

[13] Die Harnstoff als Maass des Stoffwechsels, 1858.

[14] Quoted by Moos., Henle's Zeitschrift für rat. Med., Band 7.

[15] Archiv für wiss. Heilk., Band i, and Neubauer's Anleitung, 2d edition.

[16] Ueber die Harn, &c. Aus., Nova Acta, Band 25, 1856. (Beigel's calculation is wrong; his mean number is really 1708, but I have quoted his printed number, as the difference is slight, for fear of confusion.)

[17] Pathology of the Urine, 1858, p. 25.

[18] Archiv des Vereins für wiss. Heilk., Band iii, p. 31.

[19] Ibid., Band iii, p. 2.

Name of Observer.	Amount in cubic centimetres.	Amount in fluid ounces (fractions omitted).
C. J. Lehmann[1]	2021	71
H. Ranke[2]	2039	71
Böcker[3]	2325	81
Mean in 24 hours ...	1501	52½
Mean per hour	62	2$\frac{1}{10}$

The mean amount of water excreted through the kidneys by different male adults is, therefore, remarkably diverse. One man may excrete, on an average of ten days, only 35 fluid ounces a day; another, 81 fluid ounces. The causes of this difference are stated under the different headings in the first chapter, but may be said, in general terms, to depend, 1st, on the varying quantity of water passing in; 2d, on the varying quantity passing off by the other organs (the skin, lungs, and bowels), which eliminate water; and, perhaps, 3dly, on the varying amount of water formed in the body.

In the same individual the variations from his mean amount *i.e.*, the maximum and the minimum quantity he may pass on any one day, have a considerable range, which, in round numbers, may be said to be about one fourth of the mean amount above and below the mean amount.[4] For example, if a man passes forty ounces on an average of ten or twenty days, he will be found to pass in that ten days, sometimes 30 ounces, sometimes 50 ounces, or numbers between these amounts. Occasionally, under special physiological conditions, as when the skin is very active or inactive, when much fluid is taken, or the reverse, the range may be even greater than this; but it appears that, as a rule, in the absence of any powerful physiological condition, a man seldom passes, for two days together, an amount which is very greatly above or below the limits of the range proper to him. If he does do so, some pathological condition is generally present.

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[1] Phys. Chemie, 2d edition.

[2] Mean of 30 observations on one person, communicated to author.

[3] Beiträge zur Heilkunde, 1849, and in numerous periodicals (mean of the whole on the same person).

[4] In my own case the range is exactly one fifth, the lowest amount (the mode of life being equable) is 32 ounces, the highest 48, and the mean exactly between the two, viz. 40. But in other persons the range is more, and in some cases it may be as much as one third; but the usual amount is one fourth.

2. *The Urea.*—Mean amount of urea[1] excreted in twenty-four hours by adult males, between twenty and forty years of age. The number of days furnishing the mean in these analyses is generally more than six, often ten to twenty. The lowest amounts are placed at the top of the list:

NAME OF OBSERVER.	Amount in grammes.	Amount in grains (English).
Becquerel	18·53	286·1
Parkes	24·00	371·5
Beneke[2]	24·50	378·2
Scherer[3]	27·00	416·8
Lecanu[4]	28·00	432·3
Moos[5]	28·80	444·6
Böcker[6]	28·82	444·9
Schneller[7]	29·68	458·2
Scherer (2d series)[3]	29·82	460·4
C. J. Lehmann	32·49	501·6
Neubauer[8]	33·11	511·2
Kaupp	34·66	535·1
J. Vogel[9]	35·00	540·0
V. Franque[10]	35·06	541·3
Bischoff[11]	35·10	541·9
Beigel[12]	35·69	551·0
J. Lehmann[13]	35·74	551·8

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[1] Composition of Urea—Carbon . . . . . . 20·000 per cent.
" Hydrogen . . . . . . 6·666 "
" Nitrogen . . . . . . 46·667 "
" Oxygen . . . . . . 26·667 "
100·000

Formula $C_2H_4N_2O_2 = \left.\begin{matrix}C_2O_2''\\ H_2\\ H_2\end{matrix}\right\} N_2$ viz., a diamine produced by the substitution of the diatomic radicle carbonyl (C_2O_2) for 2 eq. of H in diammonia (Hofmann).

With the exception of the analyses of Becquerel, Böcker, Lecanu, C. J. Lehmann, Scherer, and Rummel, all the analyses were made by the volumetric method of Liebig.

[2] Die Wirkung des Nord-See Bades, 1855, p. 30.

[3] Wurzburg Verhandlungen, Band iii, p. 184.

[4] Journal de Pharmacie, 1839, t. xxv, p. 681.

[5] Henle's Zeits. für rat. Med., Band vii, p. 291.

[6] Mean of all Böcker's numerous analyses. They are contained in so many periodicals, that it is impossible to give the references.

[7] Valentin's Report on Phys., Canstatt's Jahresb. for 1855, p. 108.

[8] Archiv des Vereins für wiss. Heilk., Band iii, p. 63.

[9] Neubauer's Anleitung, 2d edition, 1855.

[10] Scherer's Report on Phys. Chem., Canstatt's Jahresb., 1855, p. 206.

[11] Harnstoff als Maass der Stoffwechsels, 1853.

[12] Op. cit., p. 24.

[13] Archiv des Vereins, Band iii.

Name of Observer.	Amount in grammes.	Amount in grains (English).
Mosler[1]	36·20	558·9
Rummel[2]	36·52	563·6
Kerner[3]	38·10	588·2
Rummel	39·20	605·2
Ranke[4]	42·49	656·0
Hammond[5]	43·43	670·6
Genth[6]	44·59	688·4
Mean	33·18	512·4
Mean per hour	1·382	21

The number of analyses included in this table is so great, that we may fairly assume we have got the limits of the range of the mean amount in persons of this age and sex, except in quite unusual cases.

The mean amount of urea excreted by different adult persons is therefore almost as variable as the amount of water, and one man may excrete nearly twice the quantity which passes from the body of another person of the same sex and age. The average of eight or ten days usually gives the amount proper to the individual. If the mode of life be kept very equable, the amount remains pretty constant from day to day; but then the greatest care is necessary to keep all physiological conditions even, and to choose periods of little atmospheric vicissitude.

It should be observed, that almost all the persons, the analyses of whose urine are given above, were living well, and were taking regular exercise.

The maximum and minimum amounts passed on any one day by an individual are usually about one fifth above and below his mean amount. Thus, if the mean amount be 30 grammes in any person, the usual range is from 24 to 36 grammes, unless under unusual physiological conditions, such as large meat feeding, great exercise, &c.

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[1] Archiv des Vereins, Band iii, p. 431.

[2] Wurzburg Verhandlungen, Band v.

[3] Archiv des Vereins, Band iii, p. 627.

[4] Mean of 30 observations on one person. Communicated to author.

[5] American Journal of Med. Sc., April, 1859.

[6] Op. cit.

Becher gives the amount as high as 47·20 grammes, or 728·7 grains (Ludwig's Phys. des Menschen, 1855, Band ii, p. 261). The observation appears, however, to be made on one day only, and I have therefore excluded it from the table.

Warnecke (quoted by Moore, Dublin Med. Press, July, 1859), found the mean excretion (mean of 7 days) of an adult man to be 33·7 grammes, or 520 grains, on mixed diet.

In a very interesting paper by the Rev. S. Haughton, F.R.S. (Dublin Journal, Aug. 1859), analyses are given of all the urinary ingredients. I have not included them, however, in the table, as they refer to only a single day's excretion. In six men on good meat diet, average age thirty-five, average weight 148 lbs., the urea amounted, on the mean of the whole, to 575·87 grains in 24 hours.

The analyses of Rummel and Scherer, quoted in the above, also refer to one and two days only.

The causes of the variation in the amounts on different days, in the same or different persons, are considered in the first chapter.[1]

3. *Creatin.*[2] *Creatinin.*—The amount of these substances is not precisely known. Thudichum[3] gives 0·305 grammes, or 4·7 grains, as the average amount of creatin, and 0·453 grammes, or 7 grains, of creatinin, in twenty-four hours. They are included under the head of "Extractives," in all analyses.

4. *Urine pigment.*[4] *Urohæmatin.* *Urophæin.*—The researches of Harley[5] have somewhat modified the conclusions drawn from Scherer's researches, and seem to imply that there is only one pigment which has a very close relation to blood hæmatin, and contains iron.[6] It is, however, variable in composition, and is easily decomposed; it then gives, as pointed out by Scherer, precipitates with basic and neutral acetate of blood. The amount of pigment excreted in twenty-four hours is not known, but it evidently composes a large part of the so-called "extractives." Whether, in addition, there is any substance capable of yielding pigment, especially blue pigment, or whether

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[1] It is possible that the variations from the mean amount are not so great in the persons passing a small quantity of urea as in those passing a large quantity; i. e., that the extreme range of a man passing 20 grammes a day may be only one fifth, viz. from 16 to 24 grammes, viz. 8 grammes a day; while the extreme range in a man passing 40 grammes may be one fourth, i. e., from 30 to 50 grammes in the day. But the analyses are not yet quite sufficient for decision on this point.

[2]

		Creatin.	Creatinin.	
Composition—	Carbon	36·64	42·48	per cent.
"	Hydrogen	6·87	6·19	"
"	Nitrogen	32·06	37·17	"
"	Oxygen	24·43	14·16	"
		100·00	100·00	

Formula—Creatin . . . $C_8H_9N_3O_4+2HO$

" Creatinin . . . $C_8H_7N_3O_2$

[3] Pathology of the Urine, 1858, p. 121 and p. 130. Mean of 26 days' observations on two individuals, aged each 28 years, and weighing 70 and 72 kilogrammes.

[4] Composition (after Scherer), as far as analyses permit it to be stated:

Carbon	58·43	per cent.
Hydrogen	5·16	"
Nitrogen	8·83	"
Oxygen	27·58	"
	100·00	

[5] Wurzburg Verhandl., Band v, p. 1.

[6] Marcet (Comptes Rendus de la Société de Biologie, 1852, p. 57) was able to separate an acid from the pigment; and Harley found a resinous substance adhere so strongly to the pigment considered pure by Scherer, that it was very difficult to separate it.

urohæmatin itself will yield blue pigment, must be considered still uncertain. (See "Abnormal pigment.")

In analyses the pigment is included under the head of "Extractives."

5. *Mean amount of Extractives in twenty-four hours.*[1]—Under this head are included various substances, viz. pigment, creatin, creatinine, xanthin,[2] hypoxanthin, sarcine[3] (?), xanthoglobulin;[4] the resinous substances, called omichmyloxide by Scharling; the resin, discovered by Harley, which adheres so strongly to the pigment (perhaps the xanthin of Strahl and Lieberkühn); the acids discovered by Marcet;[5] the substances containing sulphur and phosphorus, examined by Ronalds;[6] and, perhaps, a little sugar (?).

The amount of the "extractives" excreted in twenty-four hours is not known with certainty, as the different substances cannot be isolated.

In four of Böcker's series, the amount of "volatile salts and extractives" was 16·038 grammes, or 247·6 grains. Scherer[7] noted the quantity of "extractives and uric acid" to be 24·335 grammes, or 375·7 grains, in twenty-four hours, in a man aged

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[1] In order to avoid chemical details, which are easily accessible, I beg to refer to works on chemistry, and to Thudichum's work on the urine, for the composition of these substances.

[2] Strahl and Lieberkühn, Harnsaure im Blut und einige neue Bestandtheile des Urin, 1847.

[3] Strecker, the discoverer of sarkine in flesh, conjectures that it may pass into the urine, as it is a remarkably stable body; but it has not yet been isolated (Schmidt's Jahrb., 1858, No. i, p. 16). Scherer believes sarkine to be identical with xanthoglobulin.

[4] Scherer (Canst. Jahresb. for 1857, Band i, p. 173) has discovered xanthoglobulin in normal human urine. Its constancy and amount are not known.

[5] British and Foreign Med.-Chir. Rev., April, 1853.

[6] Philosophical Transactions, 1847, p. 461. Ronalds has stated that five healthy men passed in twenty-four hours the following amount of unoxidized sulphur, which probably was in organic combination, as sulphurets very seldom occur in the urine:

1st man	4·639	grains
2d „	3·715	„
3d „	4·998	„
4th „	3·866	„
5th „	3·247	„

Griffiths (Medical Gazette, March, 1848) found 4 grains of sulphur in the urine of a healthy man.

Ronalds found in one case no less than 5·896 grains of unoxidized phosphorus.

From an expression in Thudichum's work, I infer that he questions the accuracy of these analyses, but I am not acquainted with any experiments proving their incorrectness. Both Ronalds and Griffiths are quite trustworthy; and I may put as corroborative evidence a case of mine, of rheumatism (hereafter referred to), in which an amount of unoxydized sulphur was certainly present. In dogs, Bischoff and Voit have lately shown (Die Gesetze der Ernährung des Fleischfressers, p. 281) that a large quantity of sulphur is almost always present in the urine; and special observations by Voit on this point are promised.

[7] Verhandl. des Phys.-Med. Gesellsch. zu Würzburg, Band iii, p. 180.

twenty-two; and 20·484 grammes, or 318 grains, in a man aged thirty-eight, and weighing 45 kilogrammes.

Rummel[1] gives a much smaller amount of "extractives, mucus and uric acid," viz., 15·33 grammes, or 236·7 grains; and Becquerel's average for the "extractives" is even below this, viz., 11 grammes, or 180·6 grains.

If the volatile salts, uric acid, and mucus[2] are deducted from the average of these various amounts, we obtain 15·31 grammes, or 236·3 grains, as the amount of the "extractives" in twenty-four hours. These numbers are, however, no doubt, much too high, and we may provisionally assume the true number to be about 10 grammes, or 154 grains.

6. *Mucus.*—The amount of mucus would appear, from Böcker's analyses, to be about 0·472 grammes, or 7 grains, in twenty-four hours.

Albumen.—It has been stated by Dr. Gigon, of Angoulême,[3] that albumen exists in normal urine, and can be thrown down by chloroform. This has been denied by Becquerel,[4] who considers the precipitate produced by chloroform in urine to be a mixture of chloroform, mucus, and organic substances. Gigon has reasserted his opinion, but there seems no doubt that Becquerel is correct. Aran has also made experiments adverse to Gigon's opinions.

Sugar.—Schunk[5] has shown that the pigment, when treated in a particular way, can yield sugar, or a body which decomposes the copper solution. Bruecke[6] has affirmed that, without any such decomposition, true sugar constantly exists in healthy urine. His experiments are altogether denied by Wiederhold[7] and by Lehmann,[8] who has proved that Bruecke has mistaken uric acid for sugar. Boedeker[9] has also stated that sugar is sometimes present, is sometimes absent. It is not an invariable constituent. There seems no doubt, however, that occasionally, and especially from a highly saccharine diet, small quantities of sugar pass into the urine;[10] but it can scarcely be considered as a normal ingredient.

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[1] Verhandl. des Phys.-Med. Gesellsch. zu Wurzburg, Band v, p. 116.

[2] Viz., 35 grains for the volatile salts, 8 grains for the uric acid, and 7 grains for the mucus.

[3] Quoted by Scherer, in Canstatt's Jahresb. for 1858, Band i, p. 192.

[4] Comptes Rendus, No. 21, Nov. 1857, and Gazette Médicale de Paris, 1857, p. 772.

[5] Trans. of the Manchester Literary and Phil. Society, vol. xiv, p. 239.

[6] Bruecke, in Scherer's Report on Path. Chem., Canstatt's Jahresb. for 1858, p. 77.

[7] Deutsch Klinik, 1858, No. 46.

[8] Lehrbuch des phys. Chem., 2d edit., 1859, p. 140.

[9] Henle's Zeitschrift für rat. Med., 1859, Band vii, p. 136.

[10] Bischoff and Voit have noticed this also in the dog (Die Gesetze der Ernährung des Fleischfressers, p. 269).

The preceding organic substances are either indifferent bodies or, as in the case of creatinine (and pigment?), act as weak bases. The constituents now to be enumerated are always in combination.

7. *Uric acid.*[1]—The mean amount excreted in twenty-four hours by adult males is thus given by different observers:

Name of Observer.	Quantity in grammes.	Quantity in English grains.
Neubauer (1st observation)[2]...	0·280	4·32
Beneke[3]	0·350	5·40
J. Lehmann[2]	0·396	6·11
Schulters	0·440	6·79
Neubauer (2d observation) ...	0·490	7·56
Becquerel[2]	0·495	7·64
Böcker[4]	0·495	7·64
J. Vogel[2]	0·500	7·72
Kaupp[5]	0·519	8·01
Genth[2]...	0·606	9·35
Ranke[6]	0·648	10·00
C. J. Lehmann[2]	0·700	10·80
Hammond[2]	0·915	14·14
Kerner[7]	0·939	14·49
Mean	0·555	8·569

The excretion of uric acid in different male adults, between twenty and forty years of age, is as diverse as in the case of urea, or even more so; for one healthy person may excrete three times as much as another. In the same person, from day to day, the excretion is also variable, according to Neubauer and Vogel, though Dr. Ranke informs me that, when the mode of

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[1] Composition—

Composition—	Carbon	35·72	per cent.
„	Hydrogen	2·38	„
„	Nitrogen	33·33	„
„	Oxygen	28·57	„
		100·00	

Formula—$C_5HN_2O_2 \times HO$, or as a bi-basic acid, $C_{10}H_2N_4O_4 \times 2HO$. Constitution unknown.

Almost, if not all these analyses were made by precipitation with an acid.

[2] Loc. cit. Professor Lehmann found in his own case 1·183 grammes in twenty-four hours, but he was then suffering from lung affection (emphysema and bronchitis).

[3] Nord-See Bad. p. 37.

[4] Mean of numerous analyses collected from his various publications.

[5] Vierordt's Archiv für Phys. Heilk., 1856, p. 555.

[6] Ausscheidung der Harnsaure beim Menschen, von H. Ranke, 1858, p. 6.

[7] Archiv des Vereins, Band iii, p. 627.

life is uniform, he does not find this to be usually the case. He cites, however, an exceptional case in which the variation in the same individual was very great within a short time, amounting to 66 per cent.[1] In order to obtain the average in any person, the observations must be continued over at least five days. The extremes in the same person may be, perhaps, taken as from 20 to 30 per cent., or from one fifth to one third the amount of the mean amount.

8. *Hippuric acid.*[2]—It is now admitted that hippuric acid is a normal constituent of human urine, though doubtless it is not always present.[3]

Lehmann speaks of it (I presume, from the analyses of Liebig) as "not being in much larger quantity than the uric acid."

Weismann,[4] in his own case, found on a mean of

4 days (mixed food)	2·239 grammes, or	34½ grains
3 „ (animal food)	1·109 „ „	17 „

9. *Oxalic acid.*—The existence of oxalic acid (underived from decomposition of uric acid, or of other substances) has been a matter of doubt, but it would seem to be highly probable.[5] Its amount is not certainly known. The most numerous analyses on the point are by Böcker, who found the average in his own case to be 0·092 grammes, or 1·42 grains, in twenty-four hours.[6]

10. *Formic acid* occurs occasionally in normal urine (Lehmann[7] and Campbell).[8]

Carbonic acid exists, according to Marchand,[9] independently of any ureal or other decomposition. In one experiment, 326 c.c. of urine gave 32 c.c. of carbonic acid; in another, 225 c.c. gave 23 c.c. of the acid.

11. The amounts of the *acids of Marcet, and of silicic acid,* are not known. *Valerianic acid,* which is one of the products

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[1] Ausscheidung der Harnsaure, p. 7.

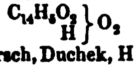
[2] Composition.—

Composition.—	Carbon	59·76
„	Hydrogen	5·09
„	Nitrogen	7·79
„	Oxygen	27·36

Formula—$C_{18}H_9NO_6$

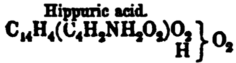
It has been considered as benzoic acid with 1 eq. H replaced by the amid. of Acetoyl:

Benzoic acid.



$$\left.\begin{matrix}C_{14}H_5O_2\\H\end{matrix}\right\}O_2$$

Hippuric acid.



$$\left.\begin{matrix}C_{14}H_4(C_4H_2NH_2O_2)O_2\\H\end{matrix}\right\}O_2$$

[3] Böcker, Dursch, Duchek, Hoefle, Haughton, have found no traces in several cases.

[4] Henle's Zeits. für Rat. Med., 1858, Band ii, p. 331.

[5] Strahl and Lieberkühn have found oxalic acid in the morning urine of many non-dyspeptic and perfectly healthy persons. (See Introduction to Book II—"Sediments.")

[6] Archiv des Vereins, Band i, p. 213.

[7] Handbuch der Phys. Chem., 2d edit., 1859, p. 285. At another place, Lehmann says that formic acid only occurs when amygdalin has been taken.

[8] Chemical Gazette, August, 1853.

[9] Erdmann's Journ. für prak. Chem., Band xliv, p. 250.

of the metamorphosis of Leucin,[1] has not yet been detected in healthy urine. Staedeler has discovered small quantities of phenylic, taurylic, damolic, and damaluric acids in healthy urine, but their amount, import, and even constant occurrence are unsettled points. Hoppe believes that they are merely products of Staedeler's process.

12. *Sulphuric acid.*—In twenty-four hours there is excreted by males, between twenty and forty years of age:

Name of Observer.	Amount in French grammes.	Amount in English grains.
Becquerel	1·123	17·34
Parkes[2]	1·339	20·67
Kaupp[3]	1·375	21·03
Beneke[4]	1·600	24·70
Krause (1st case)[5]	1·721	26·57
Buchheim (1st case[6]	1·741	26·88
Duhmberg[7]	1·804	28·85
Neubauer (1st case)[8]... ...	1·930	29·79
J. Vogel[9]	2·000	30·88
Clare[10]...	2·074	32·02
Gruner[11]	2·094	32·33
Buchheim (2d case)[6]... ...	2·105	32·50
Krause (2d case)[5]	2·270	35·05
Böcker[12]	2·302	35·56
Kerner[13]	2·478	38·26
Neubauer (2d case)[8]	2·480	38·29
Hammond[14]	2·491	38·47
Mosler[15]	2·650	40·91
Genth[16]	2·665	41·14
Mean	2·012	31·11

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[1] Neubauer, in Liebig's Annalen, Band cvi, p. 59.

[2] Mean of sixteen observations on one person, aged thirty-three, weight about 62 kilogrammes.

[3] Vierordt's Archiv, 1856, p. 555.

[4] Mean of twenty-five observations on one person (Die Wirkung des Nord-See Bades, 1855, p. 37.

[5] De transitu sulphuris in Urinam. Dorpat, 1853.

[6] Ueber die Wirkung des Glaubersalzes. Vierordt's Archiv, 1854, p. 93.

[7] Valentin's Report on Phys. for 1856, Canstatt's Jahrb., Band i, p. 112.

[8] Mean of seventeen days. Loc. cit.

[9] Loc. cit.

[10] Experimenta de excretione acidi sulphurici per urinam. Dorpat, 1854. Quoted in Valentin's Report on Phys., Canstatt's Jahresb. for 1855, p. 108.

[11] Mean of many observations on seven young men, Die Ausscheidung der Schwefelsaure durch den Harn. Giessen, 1852.

[12] Mean of the averages of several series of experiments.

[13] Archiv des Vereins, Band iii, p. 627.

[14] Amer. Journ. of Med. Sci., April, 1856.

[15] Archiv des Vereins, Band iii, p. 421.

[16] Einfluss des Wassertrinkens, 1856.

As in the cases of urea and uric acid, the average amounts of sulphuric acid are very differently assigned by different observers,[1] and the lowest average is less than half that of the highest. The difference is greater than in the case of the urea, but is less than that of the uric acid. The extremes of the sulphuric acid in the same person are considerable, from day to day. In my own case, from sixteen days' observations, the range is from 14 to 32 grains, the mean being 20·7 grains. The variation is, therefore, no less than 9 grains, or 45 per cent. above and below the mean. The greater range of the sulphuric acid over the ranges of the urea and uric acid probably arises from the varying quantities of sulphates introduced with the food. Urea and uric acid are made in the body; sulphuric acid is both made and introduced.

13. *Phosphoric acid.*—Mean amount in twenty-four hours, as given by different observers :[2]

NAME OF OBSERVER.	Amount in French grammes.	Amount in English grains.
Neubauer (1st observation)[3]	1·600	24·70
Dunklenberg (1st observation)[4].	2·134	32·94
Kaupp[5]	2·297	35·46
Dunklenberg (2d observation)[4]...	2·307	35·62
Mosler[6]	2·368	36·48
Beneke[7]	2·540	39·21
Neubauer (2d observation)[3] ...	2·587	39·94
Ranke[8]	2·690	41·53

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[1] Lehmann's average in his own case is 3·934 grammes, or 61·74 grains, a quantity which I have never seen equalled in this country in healthy persons. Generally speaking, the amounts given by German observers are higher than I should have expected from the observations I have made in England. This might arise, in the cases of Gruner and Vogel, from the Würzburg water containing a large amount of sulphates (Scherer's Report on Pathol. Chem. in Canstatt's Jahresb., 1854, p. 187); but this explanation fails in other cases, for Neubauer and Genth were at Wiesbaden, Clare was at Dorpat, and Böcker at Bonn, at the time of their observations. It must be supposed, then, that their food was rich in sulphur and sulphates.

[2] When more than one observation is quoted from each observer, it is, of course, to be understood that the observations are made on different persons. I have not quoted Becquerel's numbers, 0·417 grammes, or 6·4 grains, in twenty-four hours, (Traité de Chim. path., Paris, 1854, p. 291), as they are obviously incorrect, from the defective mode of analysis.

Almost all the observations were made by Breed's method (phosphate of iron).

[3] Anleitung zur Anal. des Harns, 2d edit., p. 266; and Archiv des Vereins, Band iii, p. 63.

[4] Liebig's Annalen, Band xciii, p. 88.

[5] Vierordt's Archiv., 1856, p. 555.

[6] Mean of two series. Beiträge zur Kenntniss der Urin-absonderung bei Gesunden, Schwangern, und Krankenpersonen. Giessen, 1853.

[7] Die Wirkung des Nord-See Bades, p. 27.

[8] Communicated to author. Mean of thirteen days on one person.

Name of Observer.	Amount in French grammes.	Amount in English grains.
Aubert[1]	2·800	43·23
Hammond[2]	2·828	43·66
Böcker[3]	2·923	45·13
Beneke[4]	2·946	45·46
Hegar (1st observation)[5] ...	2·952	45·57
Sick[6]	3·061	47·26
Neubauer (3d observation)[7] ...	3·100	47·86
Genth[8]	3·195	49·33
Kerner[9]	3·417	52·75
Krabbe[10]	3·423	52·85
J. Vogel	3·500	54·04
Breed[11]	3·732	57·62
Winter (1st observation)[12] ...	3·767	57·92
Winter (2d observation)[12] ...	4·217	65·13
Hegar (2d observation)[5] ...	4·640	71·63
Mosler (2d observation)[13] ...	4·910	75·81
Winter (3d observation)[12] ...	5·180	79·07
Mean	3·164	48·80

The same remarks apply to the phosphoric acid as to all the other ingredients; the difference between the lowest and highest average in different persons is, however, even more considerable, probably because the quality of the food and the amount of phosphates passing into the body varies greatly in different localities. The range in the same person is at least as great as in the case of the sulphuric acid, viz., from 35 to 50 per cent.

The above table gives the total amount of phosphoric acid; but some of it is united to alkalies, and some to earths. The proportion varies greatly;[14] the acid united to earths may be, to that united to alkalies from as 1 to 2½ to as 1 to 7. The following table shows this:

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[1] Neubauer's Anleitung, 2d edit., p. 266.

American Journal of Med. Sci., 1856.

[3] Mean of most of Böcker's analyses.

[4] Studien zur Urologie, Archiv des Vereins, Band i, p. 571.

[5] Zur Wurdigung der Phosphors. Erden, Archiv des Vereins, Band ii, p. 420.

[6] Archiv für phys. Heilk., 1857, Band i, p. 482.

[7] Anleitung zur Anal. des Harns, 2d edit., p. 266; and Archiv. des Vereins, Band iii, p. 63.

[8] Einfluss des Wassertrinkens, Wiesb. 1856.

[9] Archiv des Vereins, Band iii, p. 627.

[10] Canstatt's Jahresb. for 1857, Band i, p. 181.

[11] Liebig's Annalen, Band lxxviii, p. 153.

[12] Beitrage zur kenntniss der Urin-absond. bei Gesund: Inaug. Diss. Giessen, 1853, p. 30.

[13] Archiv des Vereins, Band iii, p. 421.

[14] Dr. Bence Jones has shown that the proportion of the former is dependent on the latter; that is, the earths will take phosphoric acid from the alkalies.

NAME OF OBSERVER.	IN 24 HOURS EXCRETED.			
	Phosphoric Acid united with Alkalies.		Phosphoric Acid united with earths.	
	Grammes.	Grains.	Grammes.	Grains.
Mosler (1st series)	2·650	40·91	1·152	17·78
Beneke[1]	2·118	32·70	0·663	10·23
Neubauer[2]	2·109	32·56	0·494	7·62
Beneke[3]	1·903	29·38	0·397	6·12
Mosler (2d series)	2·077	32·02	0·390	6·02
„ (3d series)	2·592	40·02	0·360	5·55
„ (4th series)	3·336	51·50	0·456	7·04
Mean[4]	2·398	37·01	0·559	8·62

Of the phosphoric acid united to earths, part is joined to lime, and part to magnesia. Professor Lehmann[5] gives the proportion as

Phosphate of lime 15, to
„ „ magnesia 7.

Kletzinsky[6] in five persons found the mean to be as 15 to 7·1, which is almost precisely the same as Lehmann's ratio.

Böcker[7] states the proportion of phosphate of lime to phosphate of magnesia to be 3 to 1. On the other hand, Neubauer[8] found the phosphate of magnesia to be in larger quantity than the phosphate of lime, and gives the proportions to be as one of the latter to two of the former. Kerner[9] also noted the amount of phosphate of magnesia to be more than double that of the phosphate of lime (0·97 to 0·37 grammes). The difference depends, of course, on the varying amounts of lime and magnesia in the food, and on the quantity of each which passes off by the intestines. The discrepancy shows, however, the great danger there is in drawing conclusions from an altered ratio of the magnesia and lime to each other in disease.

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[1] Mean of four observations. Op. cit.

[2] Archiv des Vereins, Band iii, p. 63.

[3] Mean of fourteen observations. Op. cit.

[4] The total amount is slightly below the average given by the larger number of observations in the preceding table, but this is of little consequence.

[5] Handbuch, 1854, p. 186.

[6] The mean of all the experiments gives, in 100 parts of earthy phosphates, 67·55 of phosphate of lime and 32·45 of phosphate of magnesia.

[7] Beitrage zur Heilkunde, 1849, vol. i, p. 67.

[8] Archiv des Vereins, Band iii, p. 156. The mean of all his observations gives, in twenty-four hours, 0·3098 grammes of tribasic phosphate of lime ($3CaO+PO_5$) and 0·6343 grammes of phosphate of magnesia ($2MgO+PO_5$).

[9] 'Archiv des Vereins,' Band iii, p. 627.

14. *Chlorine.*—In twenty-four hours there is excreted on an average:

NAME OF OBSERVER.	Amount in Grammes.	Amount in Grains.
Parkes (1st case)	3·36	51·87
Parkes (2d case)[1]	3·76	58·05
J. Vogel[2]	6·00	92·06
Buchheim (1st observation[3] ...	6·83	105·45
Buchheim (2d observation)[3] ...	6·84	105·60
Mosler[4]	7·01	108·23
J. Vogel[2]	8·00	123·52
Bischoff[5]	8·70	134·32
Neubauer[6]	8·93	136·87
Wilde[7]	9·56	147·60
Hammond[8]	10·02	154·80
Kaupp[9]	10·10	155·94
Kerner[10]	10·15	156·71
Hegar[11]	10·49	161·96
Beneke[12]	10·50	162·12
Genth[13]	11·22	173·23
Mean	8·21	126·76

If the whole of this chlorine were united to sodium, it would make nearly 13·6 grammes, or 210 grains, of chloride of sodium—

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[1] Mean of eight days in each case. The persons experimented on were healthy and were on full hospital diet. It is not a very abundant dietary, and that will account for the amounts of chlorine being small.

[2] Neubauer's Anleitung, 3d edit., p. 326.

[3] Vierordt's Archiv, 1854, p. 93.

[4] Op. cit.

[5] Die Harnstoff als Maass des Stoffwechsels, p. 23 (age 45).

[6] Archiv des Vereins, Band iii, p. 63.

[7] Quoted by Valentin in Canstatt's Jahresb. for 1856, Band i, p. 97.

[8] Amer. Journal, 1856, April.

[9] Vierordt's Archiv, 1854, p. 93.

[10] Archiv des Vereins, Band iii, p. 627.

The above analyses were made by Liebig's method (nitrate of mercury), or by nitrate of silver.

[11] Ueber Ausscheidung des Chlorverbindung. Giessen, 1852. I have taken the mean of all the experiments.

[12] Die Nord-See Bad., p. 37.

[13] Einfluss des Wassertrinkens. Wiesb., 1856.

I have not included Becquerel's numbers, as given in the Sem. des Urines, 1841, and in his latest work, Traité de Chim. Path., 1854, as they are known to be incorrect, like those of the phosphoric acid.

an amount which I am sure is too large, and arises from the fact that in the above table the proportion of large excreting cases is too great. It is safer, with Vogel, to put the amount of chlorine at 6—8 grammes (say the mean 7), which would give nearly 11½ grammes, or 177 grains, of ClNa in twenty-four hours. The range above and below the mean is very great, from 30 to 60 per cent., or even more, so great are the variations in ingress, and in egress by other channels.

15. *Lactic acid.*—Since the observations of Liebig, it has been generally admitted that lactic acid does not occur in healthy urine, though it is supposed to be produced very rapidly after emission, from change in the pigment. Still its absence in all healthy urines is not proved. The amount (if it does occur in health) is of course unknown, but is probably small.

16. *Ammonia.*—The existence of ammonia in healthy urine, independent of ureal decomposition, was at one time universally admitted, and subsequently almost as universally denied, chiefly on the authority of Liebig, Lehmann, and Scherer.[1] Heintz[2] and Böcker,[3] however, subsequently asserted that it really did exist, and Neubauer[4] has lately set the question at rest. It is probably united to hydrochloric acid, perhaps sometimes to phosphoric acid.

The mean of twelve experiments by Neubauer, in a man of thirty, gave:

0·8351 grammes of ammonia in twenty-four hours,
equivalent to
2·6361 grammes of chloride of ammonium.

In a man aged twenty there were:

0·6137 grammes of ammonia in twenty-four hours,
equivalent to
1·9305 grammes of the chloride.

The mean of both is:

$\left.\begin{array}{l}2\cdot2833 \text{ grammes}\\ 35\cdot25 \text{ grains}\end{array}\right\}$ of chloride of ammonium in twenty-four hours.

Böcker's analyses give a mean of 0·42 grammes of ammonia in twenty-four hours, which corresponds to 1·25 grammes, or 19·30 grains, of chloride of ammonium.

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[1] See Lehmann, Lehrbuch der Phys. Chem., 2d edit., Band i, p. 463.
[2] Heintz, Lehrbuch der Zoochemie, p. 167.
[3] Unters: über die Wirkung des Wassers (Nova Acta Acad. Cos. Leop. Card. Nat., vol. xxiv, p. 1).
[4] Journal für Prakt. Chem., lxiv, pp. 177 and 278.

Kerner[1] gives an amount nearly double this, viz. 0·83 grammes in twenty-four hours, in a man aged twenty-three, and weighing 72 kilogrammes; a quantity nearly the same as that of Neubauer.[2]

17. *Potash, Soda, Lime, Magnesia.*—Amount in twenty-four hours:

OBSERVER.	Potash.		Soda.		Lime.		Magnesia.	
	Grammes.	Grains.	Grammes.	Grains.	Grammes.	Grains.	Grammes.	Grains.
Becquerel[3]	1·7	26·36	...	79·75[3]	...	...	...	...
Neubauer[4]	...	...	...	...	0·188	2·90	0·206	3·08
Duhmberg[5]	...	...	...	...	0·412	6·36	0·273	4·21
Wagner[6]	..	...	...	...	0·170	2·62	0·172	2·66
Genth[7]	7·628	107·77	...	...	0·151	2·33	0·164	2·53
Böcker[8]	2·56	40·5	11·09	171·00	...	...	...	...

18. *Iron.*—The amount of iron is not known. The amount of all the bases probably varies greatly, owing to the varying amounts supplied in food.

SECTION II.

ON THE RELATIVE PROPORTIONS AND COMBINATIONS OF THE CONSTITUENTS, AND ON THE SYNTHETIC CONSTITUTION, OF THE URINE.

That the relative proportions of the urinary constituents must be liable to variation is clear from the fact that the water, the chlorine, sulphuric and phosphoric acids, and the bases, enter the body in very varying amounts in the food and drink, and leave it by more than one channel. The range of variation in the relative proportions between these and the other constituents is therefore very great, and their modes of combination are very various and changeable. The proportion between the substances formed in the body may be expected to be more stable, and this appears really to be the case, though even here the variations are great. The uric acid is usually to the urea as 1 to 50 or 60, but it may range, in health at least, from 1 to 40, to 1 to 80. The relative proportion of the hippuric acid is not known. The urea is to the total solids as 1 to 2 nearly, but these proportions have a wide range. The observations of Bischoff[1] and Kaupp[2] show that, as a general rule, the quantity of urea increases with the quantity of water unless this is in great excess;[3] this is true also for the (ClNa), but does not hold good for the phosphoric, sulphuric, or uric acid. The sulphuric acid formed in the body has been supposed to run parallel with the urea, and perhaps it does so during fasting hours; it is in about as 1 to 15 or 20; no such relation has yet been clearly proved between the urea and the phosphoric acid, but observations in inanition hours are not yet numerous.

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[1] Archiv des Vereins, Band iii, p. 627.

[2] Hoppe (Schmidt's Jahrb., 1859, No. 12) has lately examined this point, and finds only traces of ammonia. The quantity rapidly increases after emission. Neubauer's experiments, however, are too precise to be set aside.

[3] Includes lime and magnesia.

[4] Archiv des Vereins, Band iii, p. 63.

[5] Quoted by Valentin, Report on Phys., Canstatt's Jahresb., 1856, p. 112.

[6] Ibid., p. 98. Mean of thirteen days.

[7] Einfluss des Wassertrinkens, 1856.

[8] The mean of two series of experiments made on Herr Uhlenbrock, recorded at pp. 107 and 108 of the Zeitsch. für Hygiene, 1859, in his paper, Ueber die Einwirkung des Fettes auf die Ausscheidungen.

The exact amount of pigment has not yet been settled; but judging merely from Vogel's method, an increase of urea is usually accompanied by an increase of pigment, and the reverse.

The various ingredients enumerated are in some cases in simple solution, in others they are combined.[4]

Out of the body, urea can form a combination with chloride of sodium, but it is not yet known whether this occurs in urine. There is a sort of general relation between the amounts of urea and chloride of sodium,[5] but it is not very close, and in disease the two substances are often excreted independently of each other (in pneumonia, for instance). It is at present most probable

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[1] Die Harnstoff als Maass des Stoffwechsel, p. 21.

[2] Vierordt's 'Archiv,' 1856, p. 560.

[3] Occasionally, instances are found of only a moderate amount of water with a great amount of solids. The three following cases are from one of Hammond's papers:

	Mean amount of water.	Mean amount of solids.
1st case . . .	1474 c.c. . . .	75·3 grammes
2d „ . . .	1358 „ . . .	69·3 „
3d „ . . .	1280 „ . . .	63·13 „

Corresp. Blatt für wiss. Heilk., October, 1859.

[4] I beg to refer to an excellent article by Marcet (Brit. and For. Med.-Chir. Rev., 1853). Marcet, following chiefly Robin and Verdei, enumerates the following:—Salts, chloride of sodium, chloride of potassium(?), chloride of ammonium, carbonate of lime, sulphate of lime, sulphate of potash, basic phosphate of lime, acid phosphate of lime, ammoniaco-magnesian phosphate (? author), neutral phosphate of soda, acid phosphate of soda, phosphate of potash.

[5] Kaupp, Vierordt's Archiv, 1856.

that the urea is in simple solution. This is presumed to be the case also with the pigment and extractives; but of these substances even less is known.

The uric and perhaps the hippuric acids are combined either with soda, potash, or lime, or with all three. Oxalic acid is probably at once combined with lime, and the salt is held in solution either by a combination of organic substance (mucus) or by the acid phosphate of soda, which exerts a slight solvent effect upon it (Neubauer). The chlorine is united in great measure to sodium; sometimes in part to potassium, especially when salts of potash are introduced largely with the food; the sulphuric acid is supposed to be combined chiefly with potash, and sometimes with soda and lime. The phosphoric acid is combined chiefly with soda in the form of phosphates, with one and two atoms of fixed base; but there are also phosphates of lime and magnesia ($PO_5 + CaO + 2HO$); ($PO_5 + 2CaO + HO$); ($PO_5 + MgO + 2HO$); and ($PO_5 + 2MgO + HO$). It is probable that phosphoric acid is also in combination with potash; and sometimes, as an exceptional case, the whole of the phosphoric acid is combined with potash, and none with soda.[1] Carbonic acid may be either free or combined with lime, as bicarbonate. Ammonia exists chiefly or entirely as chloride of ammonium, and perhaps sometimes as phosphate; and iron is either combined entirely with the pigment (Harley), or is united in part with chlorine (Bergman). The combinations of silicic, lactic, and other acids, when they exist, are not known.

The mode of combination of the acids and bases is extremely variable, being influenced, 1st, by the varying amounts of soda, potash, lime, and magnesia which enter the body with the food; and, 2d, by the varying amounts of sulphuric, phosphoric, and oxalic acids, which are formed by oxidation or cleavage in the body. There can evidently be no constant and immutable composition.

Altogether, the mean quantities of the ingredients enumerated in former pages, when added together, make up about 60 to 65 grammes = 926 to 1003 grains in twenty-four hours, as the total amount of excretion.

In the following table the mean amounts of solids obtained by actual evaporation, by various observers, are given.

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[1] Thus, in Böcker's own urine the chlorine is united entirely to sodium; the phosphoric acid to potash (not to soda), lime (bibasic), and magnesia; the sulphuric acid to potash. The probable arrangement appeared to him: ($ClNa$); ($KaOSO_3$); ($2KaOPO_5$); ($KaOPO_5$); ($2CaOPO_5$); ($MgOPO_5$). (Ueber die Wirkung des Biers. Archiv des Vereins, Band i, p. 347.)

Mean amount of urinary solids in twenty-four hours, as determined by evaporation and weighing:

Name of Observer.	Amount in grammes.	Amount in grains.
Becquerel	39·52	610
Parkes [1]	41·16	635
Böcker (1st person)	53·36	844
J. Vogel	60·00	926
J. Lehmann	67·82	1046
Gorup Besanez	67·00	1034
Ranke	70·77	1092
Böcker (another person) ...	73·99	1144
Rummel [2]	76·59	1182
Mean	61·14	945

In different individuals, the mean amount of solids may be from 40 to nearly 80 grammes, and the mean amount as fixed synthetically as well as experimentally may safely be put down as 60 grammes, or 926 grains, in 24 hours, in healthy men, on good diet, between twenty and forty years of age. The range in the same person is at least one third of the mean amount from day to day.

SECTION III.

ON THE AMOUNT OF EACH CONSTITUENT EXCRETED IN TWENTY-FOUR HOURS BY A DEFINITE AMOUNT OF BODY WEIGHT.

The amount of urea excreted by one kilogramme of weight of the body is estimated, both by Professor Lehmann and Julius Vogel, at 0·500 grammes in twenty-four hours; this would give 3½ grains to each 1 lb. avoirdupois. In nine men, aged from twenty-three to thirty-five, whose weights and true mean excretion of urea are known, I find the mean excretion of urea in twenty-four hours, to each kilogramme, to be as follows: 0·420; 0·424; 0·433; 0·449; 0·451; 0·457; 0·480; 0·483; 0·529 grammes, the mean of the whole is 0·459 grammes, or 3·36 grains, to each pound avoir.; the difference between the lowest and highest amount being 0·109 grammes, or about 20 per cent. All but one of these numbers are below those given by Lehmann and Vogel; but yet the difference is not material, and probably we shall be close to the truth in receiving 0·500 grammes as the mean excretion of urea for each kilogramme in twenty-four hours.

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[1] Mean of sixteen days. Range from 424 to 882, or rather more than one third above and below the mean amount.

[2] A single day's observation. The amount is probably too high.

The weight of all the persons whose amounts of urea are tabulated in previous pages is not known; but as the mean amount of urea of all the cases is 33·18 grammes, it follows, if each kilogramme excretes 0·500 grammes, that the mean weight of all these men must have been 66 kilogrammes, or 145 lbs. avoirdupois. This is over the mean weight of men of this age in general; but it must be remembered that many of these persons were healthy, athletic, well-fed students, whose weights would be over the average. Adopting 66 kilogrammes, or 145 lbs. avoirdupois, as the mean weight of all the men whose urine has been analysed and recorded in former pages; and dividing the mean amounts of the urinary constituents before given, we get the following table:

CONSTITUENT.	In 24 hours, 1 kilogramme excretes in c.c. and grammes.	In 24 hours, 1 lb. avoir. excretes in drachms and grains.
Water	23 c.c.	2·9 fʒ
Urea	0·500 grammes	3·53 grains
Uric Acid	0·0084 "	0·059 "
Hippuric Acid[1]	0·0339 "	0·237 "
Creatin[2]	0·0043 "	0·032 "
Creatinin[2]	0·0064 "	0·048 "
Pigment and Extractives	0·151 "	1·062 "
Sulphuric Acid	0·0305 "	0·214 "
Phosphoric Acid	0·048 "	0·336 "
Chlorine[3]	0·126 "	0·875 "

Let us test these figures by the results obtained by others. We have already seen that the urea from the nine cases I have assembled is a little below the amount in the table (0·459 to 0·500), but the difference is immaterial.

The amount of uric acid in relation to weight is so variable in different persons, that I find the amount given in the table must be allowed wide limits of variation.

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[1] These numbers are probably incorrect; they are obtained by using Weissmann's imperfect analyses.

[2] The amounts of creatin and creatinin are taken from Thudichum (mean in two men); but as the two men weighed not 66, but 70 and 72 kilogrammes, I have calculated the excretion upon the mean of these weights.

[3] I have taken the chlorine at 7 grammes, or 108 grains. The amount of bases is so uncertain that I have not ventured to put in the figures.

Lehmann[1] says that one kilogramme in adults excretes, in twenty-four hours, 0·032 grammes of sulphuric acid. In two of my cases I found the amount 0·035 and 0·032 grammes, which is a little over the quantity given in the table.

The mean of the experiments of Hegar, Gruner, and Winter, give 0·064 grammes of phosphoric acid in twenty-four hours to each kilogramme, an amount which is over the quantity put down in the table. Some observations of Beneke's on himself, at different times, give the following numbers: 0·046; 0·039; 0·0427; 0·0426; 0·0315; the mean being 0·0403. This, on the other hand, is a little below the amount in the table.

It appears, therefore, clear that the amounts given in the table must be tolerably near the true quantities, and may be safely adopted.

The limits of variation above and below the mean excretion, according to weight, are certainly considerable. If we compare two persons, we find that one may excrete in twenty-four hours only 0·390 grammes (Beneke in one series), and another 0·529 grammes of urea to each kilogramme. And variations as great occur in the other ingredients. Also in the same person the amount of urea excreted by each lb. weight of the body at different times varies rather largely (even occasionally as much as 20 per cent.); so that certainly we must allow a wide range of mean maximum and minimum excretion, above and below the mean recorded in the table. In the other ingredients, the maximum and minimum excretion of each lb. weight is even greater than in the case of the urea.

SECTION IV.

ON THE AMOUNT OF THE ACIDITY OF THE URINE.

The acidity depends on a general excess of acids over alkalies; the immediate cause may be various, and may depend either entirely on acid phosphates (other acids, such as SO_3, hippuric and uric, being in large quantities) or, in addition, on the presence of an organic acid[2] (lactic? butyric? valerianic?), or of some acid salt, other than the phosphate.

The amount of the acidity, as determined by careful neutralizing with soda,[3] is often conveniently expressed by saying

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[1] Handbuch, 2d edit., 1859, p. 286.

[2] The acidity should always be determined as soon after the urine is passed as possible, as it rapidly increases in most specimens of urine.

[3] Archiv des Vereins, Band iii, p. 627.

(not that it is equal to so much alkali, but) that it is equal to so much crystallized oxalic acid. Reckoned in this way, the acidity in twenty-four hours in male adults is thus given by different observations:

NAME OF OBSERVER.	Acidity equal to grammes of Oxalic Acid.	Acidity equal to grains of Oxalic Acid.
Winter	2·375	36·67
„ (another man)... ...	1·924	29·70
Vogel	2 to 4	30·88 to 61·76
Kerner...	1·949	29·99

SECTION V.

ON THE SPECIFIC GRAVITY OF THE URINE.

The specific gravity of healthy urine has a mean of 1020, and ranges from 1012, or lower, to 1030 or higher. The variations depend especially on the varying amount of water, which causes the solids to be in relative greater or less quantity, and on the varying amount of solids. Of the various solids, the quantities, 1st, of the urea, 2d, of the pigment, 3d, of the chloride of sodium, and 4th, of the remaining constituents, must be supposed to be the most important. The specific gravity cannot point out which ingredient is affected, and great changes may occur in relative constitution without any alteration in the specific gravity. For example, the urea may be greatly increased, and yet, owing to lessening of the chloride of sodium, the specific gravity may be unaltered, &c., &c.

The rules for determining the solids by the specific gravity (multiplying the last two figures of the specific gravity by 2 for most cases, and by 2·33 for diabetic urine, which gives the amount in grammes in 1000 c. c.) give merely approximative results; yet, on account of the ease of determining the specific gravity, they are useful.

SECTION VI.

ON THE ORIGIN OF THE URINARY CONSTITUENTS.

1. In health, the *water* of the urine is derived entirely, or almost entirely, from the water of the liquid or solid food. Schmidt's experiments on cats show, however, that water is

sometimes formed in the system;[1] but whether this passes off by the kidneys is not known. Its amount is probably small.

2. The *urea* is the product of the metamorphosis of the nitrogenous tissues, and it would appear that in cats (Schmidt) and in dogs (Bischoff and Voit[2]), and, perhaps, in all flesh feeders, it contains all, or almost all, the nitrogen which enters the body. In man, however, nitrogen passes off in the uric and hippuric acid, in the pigment, in the creatin and ammonia of the urine, in the urea and other organic compounds (?) of the skin (Schottin and Funke[3]), in the fæces to a small extent, and in the ammonia of the breath (?); so that the renal urea represents not more than two thirds or four fifths of the nitrogen of the ingesta.

As, however, it represents so large a quantity, it is evident that the urea is furnished by almost all the nitrogenous tissues, either at once or from other products being formed in the first instance, such as creatin and uric acid, or gelatinous compounds. The muscular tissue is, in all probability, its greatest source. It is possible that it is formed largely in the liver. (See "Liver Diseases.")

In starving animals, as stated by Berzelius, the urea can only come from the tissues, or from the albuminous constituents of the blood.

If Bischoff's latest experiments are correct, it appears that the nitrogenous constituents of the blood (albumen, fibrine, &c.) do not break down into urea under the influence of the inspired oxygen; and that, to form urea, the chemical attractions and repulsions going on in living tissues are necessary (Bischoff and Voit[2]).

If urea is actually formed in the blood, it is, therefore, according to Bischoff, not from fibrine, albumen, or hæmatoglobulin, but from other substances which have entered the blood as the effete products of tissues,[4] such as creatin and creatinin from the muscles, &c.

This statement, if true, would settle at last the much controverted doctrine of the "luxus consumption" of the albuminous food (Bidder, Schmidt, and Frerichs),—that doctrine which teaches that the well-known increase of urea in the urine, soon after meals, arises simply from the surplus albuminous material (which is not required by the system) being at once converted into urea. The enormous increase in urea has seemed to many persons to completely prove this doctrine; but Bischoff and Voit have now given strong grounds for believing that it is incorrect, and that, in this case, as in all others, the increase in the urea proceeds from the increased metamorphosis of the formed tissues, and that albuminous food in the blood can no more be acted on by oxygen, than the albumen in the blood of the fasting animal can be so acted on.

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[1] Valentin (Brinton's Trans., p. 327) speaks of it as being about one fourth or one sixth of the water of the food, but states that the experiments are not trustworthy. Schmidt's numbers give a much smaller amount.

[2] Die Gesetze der Ernährung des Fleischfressers, 1860.

[3] Moleschott's Untersuchungen, Band iv, p. 36.

[4] It is scarcely necessary to say that the supposed artificial production of urea from albumen, by Bechamp, has been shown to be a fallacy by Staedeler. Benzoic acid, however, was actually produced.

The point is of extreme interest to physicians, and it is to be hoped that physiologists will soon be able to pronounce definitively upon it.

3. That the *uric acid* is also a product of tissue metamorphosis is certain, but its exact places of formation are unknown. It is found largely in the spleen (Scherer), and in some amount in the lungs (Cloetta and Wiederhold), and in the liver, brain, &c.; but it would be premature to conclude it is produced in these organs, or is found nowhere else.

Is uric acid also formed at once from food, without having been a constituent of any tissue? That it increases after food is certain, and possibly Prout's statement that this increase is greater after indigestible food may be correct, though full observations are yet wanting on the point. But if the urea is *only* formed from tissue, the uric acid must be also presumed to have only a similar origin. For if uric acid were formed directly in the circulation, from the action of oxygen on albuminous food, urea would be also so formed; for uric acid introduced into the blood breaks down entirely into urea and other substances (Wöhler and Neubauer). So that the rule respecting the formation of urea, must apparently govern the formation of uric acid.

One difficulty, however, occurs here. While the complete destruction of uric acid *introduced* into the body is quite certain, it is as certain that uric acid, or some amount of it, *produced* in the body is not so destroyed, but passes off with the urine; why should we not suppose that the unknown conditions, which in this case protect the uric acid, may be also protective, if uric acid is formed directly from food? In other words, is the parallel drawn between uric acid artificially introduced, and uric acid supposed to be produced from food in the circulation, a correct one; and is the argument deduced from it valid?

We do not, at present, know enough of the transformation of uric acid into urea to enable us to give an answer; but we may safely say, that if uric acid be produced from food in the circulation, it must be destroyed and pass into urea, unless some protective influences are present; and that there is, so far, no evidence whatever that such protective influences *are* present.

So that, unless we introduce an unauthorised conjecture here, we must suppose that if urea is formed only from tissues, uric acid must have only a similar origin.

The easy conversion of uric acid into urea, both in and out of the body, led Liebig at once to the supposition that uric acid is only a prior stage of transformation of urea; and if this view be pushed to its legitimate conclusion, it would affirm that all the urea has passed through the preliminary form of uric acid. But this view has never been thoroughly established, and is, in fact, in very much the same position now as when it was propounded; the comparative constancy in the amount of uric acid, within narrow limits, and the want of connexion between its changes and the changes in the urea, in health and disease, seem to offer extremely strong arguments against Liebig's supposition, and show, at any rate, that some further expression of the phenomena is necessary. Arguments against Liebig's hypothesis are also generally drawn from the condition of the urine in the several classes of animals (birds, serpents, &c.); but as the real amount of oxidation in these animals is very imperfectly known, this argument is not a strong one.

4. The *hippuric acid* would seem to be a very frequent constituent. Is it, in man, derived from tissues or immediately from food, or from both sources? That it is derived from the tissues of vegetable feeders is certain, as it occurs during fasting, and when their food contains no benzoyl compound (Hallwachs). But in man it seems to disappear during fasting, and not merely to lessen, as the urea and uric acid do; so that its tissue origin is uncertain.

That it is formed at once from some kinds of food is quite made out. Any compound containing benzoic acid, or a derivative of benzoyl, will produce it by union with glycin in the hepatic circulation; or in the general circulation, if glycin happen to be there. (See "Benzoic acid.")

But it is not necessary that food should contain benzoyl. As already said, no compound of the class is contained in the food of the herbivoræ; and as it has now been shown by Guckelberger, Staedeler, and Hallwachs, that nitrogenous substances can yield benzoic acid by artificial oxidation, it may be inferred that the same thing may occur in natural oxidation; and that the benzoic acid thus formed will take glycin, as usual, and form hippuric acid. In what other way can we account for the fact that, on a strict animal diet, Weissmann[1] still found some amount of hippuric acid in his urine? This must have come from food or tissue; if from tissue, why is it not found in fasting animals?[1] All nitrogenous substances, however, will not produce hippuric acid. From experiments on rabbits, Weissmann has concluded that protein matters do not give it. In men, also, he thinks vegetable albumen is wholly indifferent! As might be anticipated, starch, neither in rabbits or men, causes it; nor, according to Hallwachs, does chlorophyll. In rabbits, Weissmann thinks (without, it seems to me, any convincing evidence) that it is the "encrusting substance" (lignin?) which forms benzoic and then hippuric acid.

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[1] Henle's Zeitsch. für rat. Med., 1858, Band ii, p. 331.

Another possible mode of origin has been indicated, which would show an origin from tissue, in all probability. Von Maack[2] has pointed out that tyrosin, which contains two atoms more of hydrogen than hippuric acid, might form this latter by oxidation, thus:

$$\underset{\text{Tyrosin.}}{C_{18}H_{11}NO_6} = \underset{\text{Hippuric Acid.}}{C_{18}H_9NO_6} + \underset{\text{Water.}}{2HO}.$$

If the doubtful statement that succinic acid produces hippuric acid be correct, it is, at present, quite inexplicable. (See chap. ii.) Hippuric acid in the circulation does not form urea.

5. The *pigment* is believed to be derived from the colouring matters of the blood-cells; and, perhaps, it is not going too far to assume its amount to be a measure of their metamorphosis.[3] Whether it at once comes from the blood pigment, or through the intermediation of bile pigment, is uncertain.[4]

6. The origin of the "*extractives*" (other than the pigment) is uncertain; the creatin and creatinin are probably derived from muscles, and Liebig's latest observations show that the creatin is a product of creatinin ('Annalen der Chem. und Pharm.,' Bd. 108, p. 354), so that it is even questionable if creatin is a normal constituent of the urine, or is merely a product of decomposition of creatinin. The sources of the resinous substances, the sarcine, the various acids described by Staedeler, &c., are quite unknown.

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[1] It would be well to repeat the analyses on starving animals. The hippuric acid may only have been overlooked.

[2] Archiv für Wissensch. Heilk., Band iv, p. 100.

[3] It is a very important point to measure the amount of pigment, but as unfortunately it cannot be isolated, this can only be done by imperfect methods. The best is that devised by Professor Vogel; viz., the comparison of a stratum of urine of definite thickness with a standard table of colours.

[4] The identity of hæmatoidin and bilifulvin (Valentiner and Kerner) seems now to be beyond doubt; and the very close resemblance of urine pigment to bilifulvin is strongly suggestive of an hepatic origin. Kühne's experiments on the destruction of blood-cells by the bile acids may possibly explain hereafter the exact mode of origin. An argument in favour of a liver origin may perhaps be drawn from the effect of liver-diseases on the urinary pigment.

7. The *sulphuric acid* is in part at once derived from the sulphates of the food. During fasting it is formed from the sulphur of the albuminous tissues. Perhaps it comes in great part from the sulphur-holding taurin and cystin, which can be found in the liver, lungs, and other parts of the body, but not generally in the excretions, and which, therefore, must be broken up. At present, however, all that can be said of sulphuric acid is that it may be taken as a measure of metamorphosis of sulphur compounds *during fasting*. About one third of the sulphuric acid of the urine is derived at once from food; the remainder comes from the oxidized sulphur-holding tissues.

All the sulphur entering the body is not excreted by the urine; some passes off in the stools (Marcet), some by the skin—in perspiration, hair, nails, and cuticle.

8. *Phosphoric acid* is in part derived from the food at once; in part from metamorphosis of the phosphorus of the nervous, and of the muscular tissues, of the bones, of the blood-cells, and of all parts containing phosphorus or phosphates. A large amount of earthy phosphates pass off by the bowels (unabsorbed portion of food?).

9. *Chlorine* is of course derived entirely from the food; about three fourths of what is taken passes off by the urine,[1] and one fourth by other channels, chiefly the skin, as scarcely any is found in healthy stools. Wiederhold has tried to show that some passes with the breath. As it composes parts of almost all tissues, it is increased by their disintegration, if this takes place without the supply of chlorine being cut off, or without retention in the body.

10. The *alkalies* and *earths* are of course obtained from the food, with the exception of ammonia, which is probably formed in the system (from leucin? Neubauer). They then enter into the composition of all tissues. Potash exists largely in the muscles, and in the red particles of the blood; soda, in the serum of the blood. But both are present in almost every part. The lime proceeds especially from the metamorphosis of bone, though the amount of this is small; the lime and magnesia of the food pass out in very small amount by the urine, but largely by the bowels.

We are not at present in a position to connect the amount of a urinary constituent with the metamorphosis of a particular tissue; but other symptoms will often enable us to do so. Thus, an acute disease of the nervous centres would prove that these, and not the muscular tissue or the bones, are the origin of a large quantity of phosphoric acid which is found; the rapid wasting of the muscles in acute rheumatism, or in typhoid fever, would show that the large amount of urea found in these diseases is derived from metamorphosis of muscular tissue. The examination of the amount of the constituents of the urine is, then, at present not so much an aid to diagnosis of a special tissue disease, as a measure of the process whose presence is known from other symptoms. As the subject is better known, however, it will pass beyond this point.

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[1] In the dog, all passes by the urine eventually (Bischoff, Ernahrung des Fleischfressers, p. 277).

It will be seen in subsequent chapters that the urinary ingredients can vary in amount in four ways. They may be increased—

1. Because their formation in the body is increased, or because they enter the body in large quantity.
2. Because their elimination is increased (formation and ingress being unchanged).

They may be diminished—

1. Because their formation, or entrance into the body, is lessened.
2. Because their elimination is lessened (formation and ingress unchanged).

Can there also be a perverted metamorphosis; *i. e.*, can uric acid be formed instead of urea, or the reverse? No positive decision can be come to at present, on this point.

SECTION VII.

ON THE ABSOLUTE AND RELATIVE AMOUNTS OF THE URINARY AND THE OTHER EXCRETIONS.

As the amounts of the secretions from the bowels, skin, and lungs are often referred to in the following pages, it seems desirable to give such a summary of this important subject as may enable the reader to form an opinion as to the increase or decrease of the excretions, when the amounts are stated.

The estimations of Sanctorius, Anselminus, Seguin, Dodart, Dalton, &c., are given in all works on physiology; and I shall, therefore, confine myself to the most recent observations.

Total amount of Ingesta and Egesta in twenty-four hours (omitting the inspired Oxygen).

Authority.	Sex.	Age.	Weight in kilogrammes	INGESTA.		EGESTA.					
				Solid and Liquid.		Urine.		Fæces.		Excretions from Skin and Lungs.	
				Grms.	Grains.	Grms.	Grains.	Grms.	Grains.	Grms.	Grains.
Valentin [1] .	m.	...	53·2	2924	45158	1448	22363	191	2950	1247	19258
Gross [2] . .	m.	16	41·4	2552	39402	1329	20519	118	1821	935	14436
Gross [3] . .	m.	18	38	2471	38152	1843	28455	156	2408	1010	15594
Laun . .	m.	60	76 to 78	3380	52187	2000	30880	170	2624	1110	17138

One kilogramme of body weight, therefore, received and excreted in twenty-four hours—

Authority.	Ingesta to 1 kilogramme in 24 hours.	Egesta to 1 kilogramme in 24 hours.		
		Urine.	Fæces.	Insensible Perspiration from Skin & Lungs.
	Grammes.	Grammes.	Grammes.	Grammes.
Valentin	54·7	27·1	3·6	23·4
Gross (1st case) [4]	62	32·3	2·8	22·7
„ (2d case) [5]	65	48	4	26·5
Laun [4]	43·9	26	2·3	14·4

The excretions in 100 parts were, therefore—

Authority.	Urine in 100 parts of excretions.	Fæces in ditto.	Excretions from Skin and Lungs in ditto.
Valentin	50·1	6·6	43·2
Gross (1st case)	55·8	4·97	39·23
„ (2d case)	61·2	5·1	33·7
Laun	61	5	34

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[1] Text-book of Phys., translated by Brinton, p. 325 (587 grains, or 38 grammes, were retained in the body—gain in weight).

[2] Ueber das Verhältniss der sen. zu den insen. Ausscheidungen, Inaug. Diss. Giessen, 1855. (Retained in body, 170 grammes in the first case; loss of weight in the second case, 538 grammes.)

[3] Valentin's Report in Canstatt's Jahresb., 1857, Band i, p. 89. Gain of weight, 100 grammes.

[4] Some of the ingesta were retained in the body in these three cases = gain of weight.

[5] Loss of weight in this case—excess of excretion over ingesta.

Beneke[1] gives several accurate determinations from observations carried over six and twelve days.

First series, six days; three healthy males.

Name	Age.	Weight Kilogrm.	Height. Cent.	Ingesta in grammes.			Egesta in grammes.			
				Solids[2]	Fluid.	Total.	Urine.	Intestines.	Skin and Lungs.	Total.
B.	35	62·5	181	965	1733	2698	Water 1247 Solids 45	163	1276	2731
Mm.	25	65·5	180	975	1733	2708	Water 1134 Solids 49	105	1488	2776
Ma.	24	76	181½	1102	1760	2862	Water 1484 Solids 58	21	1301	2864

Second series, six days; three healthy males.

B.	as above.	as above.	as above.	1101·8	1800	2901·8	1811·4	153·6	1015·9	2980·9
Mm.	as above.	as above.	as above.	1189·3	1800	2989·3	1717·6	146·5	1248·0	3112·1
Ba.	23	71·5	177½	1286·7	1800	3086·7	1830·4	165·3	1215·6	3211·3

When kept on a diet somewhat regulated, and, therefore, insufficient, it will be seen that all these experimenters lost weight. Adding the two series together, we obtain the following per-centages:

Per-centage amount of the excretions.

Name.	Age.	Urine.	Fæces.	Skin and Lungs.	Total.
B.	35	54·3	5·6	40·1	100·0
Mm.	25	49·3	4·2	46·5	100·0
Ma.[3]	24	53·9	0·7	45·4	100·0
Ba.	23	56·9	5·1	38	100·0

Mosler[4] has made some observations on children, young men, and women.

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[1] Ueber Nauheim's Soolthermen, 1859, p. 37, et seq., and p. 139, et seq.

[2] The term "solids" includes the water of the solid food.

[3] It was questionable, however, whether the person designated Ma. was in perfect health, as during the whole six days he suffered from constipation, so that, instead of 140 or 160 grammes, only 21 were discharged through the intestines per diem.

[4] Archiv des Vereins für wiss. Heilk., Band iii, p. 398 (1857).

One kilogramme of body weight excreted in twenty-four hours—

	Urine.	Fæces.	Skin and Lungs.
	Grammes.	Grammes.	Grammes.
In children	81	21	53
In young women . . .	38	3·25	17·5
In young men . . .	38·8	7·73	20·1

The per-centages were therefore, of the total excretions, according to Mosler—

	Urine.	Fæces.	Skin & Lungs.	Total.
In young men . .	58·2	11·6	30·2	100·0
In young women . .	64·7	5·5	29·8	100·0
In children . . .	53	13	34	100·0

The very rapid metamorphosis and the great elimination in children is well seen by a reference to the amount excreted by each kilogramme of body weight; the amount of urine is double that of the adult; the fæces three- to six-fold; the skin and lungs excretions more than double. The increased activity manifests itself everywhere, but comparatively more in the intestinal, skin, and lung excretions, than in the kidneys, as is seen by reference to the per-centage accounts.

The relative amount of the various excretions is evidently subject to great variety, from sex, age, food, and other influences. Speaking very generally, it can now only be said, that in adult men the proportions in 100 parts of excretions are—

Urine	48 to 62
Fæces	4 „ 8
Skin and lungs	30 „ 46

The relation of the ultimate elements (*i. e.* the nitrogen, carbon, hydrogen, and oxygen of the various excretions) to each other, is a physiological problem of the greatest importance to physicians; that this relation, in flesh-feeders, is regulated by the most constant laws, must be admitted, from Bidder and Schmidt's, and Bischoff's and Voit's investigations.

In men, the amounts cannot be so perfectly fixed, but I subjoin Barral's experiments, and the latest statements I have been able to find, viz., those given by Vierordt and by Fick, in their recent works.[1]

The mean experiments of Barral, as given by Ludwig,[2] are—

1st series.—Time, 5 days; weight, 47·5 kilogrammes.

	For 1 kilogramme in 24 hours, in grammes.[3]					
	C.	H.	N.	O.	HO.	Total.
Ingesta—						
In the food	7·7	1·2	0·6	7·0	42·1	...
Through the lungs ...	...	...	...	22·3	...	...
Egesta—						
Through insensible perspiration (skin & lungs)	7·06	1·09	0·31	28·94	17·31	54·71
Through the kidneys ...	0·32	0·36	0·23	0·17	22·56	23·34
Through the bowels ...	0·32	0·05	0·06	0·19	2·23	2·85

2nd series.—Time, 5 days; weight, 47·5 kilogrammes.

Ingesta—						
In the food	5·6	0·9	0·4	4·0	38·8	...
Through the lungs ...	...	...	...	16·4	...	..
Egesta—						
Insensible perspiration ...	5·12	0·81	0·16	20·13	17·06	43·28
Kidneys	0·29	0·06	0·21	0·15	20·59	21·30
Bowels	0·19	0·03	0·03	0·12	1·15	1·52

These observations make the exit of nitrogen by the skin and lungs much greater than is now usually supposed to be the case; in the first series more than 50 per cent. is stated to emerge in that way, whereas it is usually assumed that 75 per cent. passes by the kidneys: the salts, sulphur and phosphorus, are disregarded.

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[1] Vierordt, Grundriss der Phys. des Menschen, 1860, p. 184. Fick, Compendium der Phys. des Menschen, 1860, p. 445.

[2] Lehrbuch der Phys. des Menschen, 1st edit., 1856, p. 442.

[3] These numbers, multiplied by the weight (47·5 kil.), give the total amount of each ingredient, received or excreted in twenty-four hours.

Vierordt's Calculation.

Ingesta and Egesta of an healthy adult man.

Ingesta in 24 hours (in grammes).[1]

(The O and H of the starch are taken as water.)

	Total.	Water.	C.	H.	N.	O.	O of the atmosphere.	Salts.
From the atmosphere	744·1	...	...	...	...	...	744·1	...
Albuminous bodies ...	120	...	64·18	8·60	18·88	28·24	...	...
Fats	90	...	70·20	10·26	...	9·54	...	...
Starch	330	183·18	146·82	...	...	...	...	...
Water	2635	...	...	...	...	...	...	...
Salts	32	...	...	...	...	...	...	32
	3951	183·18	281·2	18·86	18·88	37·88	744·1	32
						781·99		

Egesta in 24 hours (in grammes).

From the lungs ...	1229·9	330	248·8	...	...	651·15	...	...
„ skin ..	669·8	660	2·6	...	...	7·2	...	...
„ kidneys ...	1766	1700	6·8 3	2·3 1·0	15·8	9·1 2	...	26
„ intestines .	172	128	20	3·0	3·0	12	...	6
Total	3837·7	2818	281·2	6·3	18·8	681·45	...	...
Formation of Water .	113·1	...	...	12·56		132·54	...	...
	3950·8					781·99		

The per-centage amounts of this table are—

By the lungs	32 per cent.
„ skin	17 „
„ intestines	4·5 „
„ urine	46·5 „
	100·0

It will be observed that Vierordt does not assign any salts to the perspiration, but includes them all in the urine and fæces; the sulphur and phosphorus are also not distinguished, nor does he assign any nitrogen to the skin.

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[1] Any of these amounts, multiplied by 15·44, will give the amount in grains.

Professor Fick's table is taken from Hildersheim:[1]

Ingesta in 24 hours, in grammes, for men of from 50 to 60 kilogrammes weight.

	HO.	C.	H.	N.	O.	S.	P.	Salts.	Fat.
From the atmosphere .	..	..	..	..	713·425	..	..	..	..
By the food—									
116·928 grammes of Albuminates .	..	62·451	8·172	18·094	25·680	1·868	0·466	..	..
119·728 grammes of Fat	..	90·831	13·633	..	11·777	..	..	..	4·411
263·088 grammes of Starch . .	145·784	116·627	..	..	..	..	..	..	..
2626·846 grammes of Water . .	2626·846	..	..	..	..	..	..	..	..
19·527 grammes of Salts	..	..	..	..	..	..	..	19·527	..

Egesta.

	HO.	C.	H.	N.	O.	ClNa.	Earthy Phosphate.	Salts generally.	Fat.
From the lungs . .	410·521	227·840	0 003	0·015	607·575	..	..	..	..
„ „ skin . . .	791·645	4·117	0·552	1·399	2·036	(?)	(?)	0·080	..
„ „ kidneys . .	1583·778	18·539	3·742	13·334	9·784	7·117	0·991	19·485	..
„ „ intestines . .	117·849	19·413	2·951	3·346	11·551	0·501	2·492	5·667	4·411
Total . . .	2903·793	269·909	7·248	18·094	630·946	7·618	3·483	25·232	4·411

In addition to the H and O of the starch which are taken as water, 131 grammes of water are presumed to be formed in the system. The qualities of the water and of the H and O in the columns of ingesta and egesta do not, therefore, correspond in the two tables.

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[1] Hildesheim, Die Normaldiät, Berlin, 1856. For much fuller details on this subject, and on the relation of the food to the excretions, I beg to refer to Hildesheim's masterly work.

CHAPTER I.

ON THE VARIATIONS IN THE URINARY EXCRETION DURING HEALTH, FROM PHYSIOLOGICAL CONDITIONS.

The composition of the urine varies greatly in different individuals, and in the same individual from day to day, owing to the unequal influence of varying physiological conditions. It is no easy matter to assign to each of these conditions its exact influence, and all that can be at present attempted is an enumeration of them, and an approximative estimate of their several effects.

SECTION I.

SEX.

Excretion of urine in adult women.—Becquerel has stated that women excrete more urinary water, but less solid matter, than men, but this is incorrect. Some women may pass more water and more solids than some men, but (if weight be disregarded), as a rule, females excrete both less urinary water and solids than the other sex.

The urine has not been so carefully analysed in women as in men. Placing together the observations of Becquerel,[1] Lecanu,[2] Bischoff,[3] Mosler,[4] Beigel,[5] and Ranke,[6] the following table gives the mean of numerous analyses in twenty adult women, between sixteen and forty years of age.[7]

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[1] Traité de Chimie path., 1854, p. 278.

[2] Simon's Chemistry, by Day, vol. ii, p. 165; and Journal de Pharmacie, 1839, t. 25.

[3] Die Harnstoff als Maass der Stoffwechsels, 1852.

[4] Beitrage zur Kenntniss der Urin-absonderung, Giessen, 1853; and Archiv für wissenschaft. Heilk., Band iii, p. 410, et seq.

[5] Unters. über die Harn., &c. Aus Nova Acta, &c., Band xxv, besonders abgedruckt, p. 20, et seq.

[6] Ausscheidung der Harnsaure, p. 7.

[7] In an "adult woman" (exact age and weight not given), Warnecke found the mean of seven days to be 26·8 grammes, or 414 grains, on mixed diet (quoted by Moore, Dublin Medical Press, July, 1859). As the age is uncertain, I have not included it.

Urine of adult women in twenty-four hours.

Ingredients.	In cubic centimeters and grammes.	In fluid ounces and grains.
Urinary water	1303	42·0
Urea	24·61	390·0
Uric acid	0·473	7·3
Chlorine	6·41	98·9
Sulphuric acid	1·96	30·2
Phosphoric acid	3·64	56·2
Extractives, bases, and other ingredients ...	9·65	149·0

The mean amount of urea in different women may vary from 12 to 30 grammes, but it is usually from 16 to 28.

The excess of the phosphoric acid over the mean amount in adult men, probably merely arises from the analyses in which phosphoric acid is given being too few in women, so that the mean amount is placed at a higher figure than it will be when the analyses are more numerous.

The excretion of urea, according to weight, cannot be given at present with any certainty, but the following are the principal facts known:

Urea.

Observer.	Weight. Kilo-grammes.	Urea in 24 hours. Grammes.	1 kilogramme excreted grammes.	1 lb. excreted grains.
Mosler, in three women (mean of the whole)	42	25·55	0·6	4·21
Beigel, in six women (mean of the whole)	64	27·65	0·432	2·9
Rosenstein, in one woman[1]	60	25·13	0·419	2·94
J. Lehmann[2]	48·75	17·6	0·361	2·53
Valentin (from Lecanu's analyses) ...	60	19·116	0·32	2·24
Mean	54·95	23·01	0·414	2·96

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[1] Virchow's Archiv, 1859, Band xvi, p. 211. The chloride of sodium in this woman amounted to no less than 25 grammes (= 386 grains) in twenty-four hours, in consequence of a very salt, rich diet.

[2] Archiv für wiss. Heilk., Band iv, p. 500.

If the mean weight (55 kilogrammes, or 121 lbs. avoird.) be considered the same in the case of the other ingredients, we obtain the following table:

	1 kilogramme excretes in 24 hours, in grammes.	1 lb. av. excretes in 24 hours, in grains.
Water	23 c.c.	2·9 fʒ
Urea	0·414	2·96
Uric acid	0·0086	0·06
Chlorine	0·116	0·817
Sulphuric acid	0·035	0·25
Phosphoric acid	0·066	0·464

It would, then, seem probable (though it is certainly not proved) that women excrete, according to weight, a little less urea than men (1 kilogramme in women = 0·414; in men = 0·459 gramme, or 0·500; p. 24, Introduction). Professor Lehmann[1] and others have already stated that the amount of urea to weight is less in women than in men, an opinion based on Valentin's figures.

The range of urea in different women appears to be quite as great as in men (from 0·600 to 0·320 gramme per kilogramme, in twenty-four hours).

The other ingredients are excreted in ratio to weight in very nearly the same proportion as in men; the slight excess of phosphoric acid is probably owing to the analyses in women being few in number, so that the amount is too high.

The deviation in women from the mean amount is as great as in men. Many women secrete on an average only 12, 14, or 18 grammes of urea daily; others 28 to 30. The usual individual range appears to be about 4 or 5 grammes above and below the mean amount proper to the person.

No satisfactory experiments have as yet been made on the effect of sex at different ages; the few facts known are included in the next section.

SECTION II.

AGE.

Fœtus.—The urine of the fœtus is either slightly acid or neutral; it is destitute of urea[2] and is highly albuminous, and sometimes bloody (Prout, Moore,[1] Stockvis[2]). Moore, however, found that a considerable quantity of nitrogen was obtained by the action of the hypochlorite of soda (Davy's test for urea), which he conjectures may have been derived from allantoin. This substance was not, however, isolated. Brande found no uric acid, while Prout discovered a considerable quantity. In the fœtus of the cow and sheep, the urine is saccharine (Bernard[3]); whether this is the case with the human fœtus is uncertain. Stokvis,[4] in a five-months' fœtus, and Moore, in four specimens of different ages, found no sugar. Moore noticed a large quantity of "pavement epithelium" (kidney?).

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[1] Handbuch der Phys. Chem., 1859.

[2] Moore, Heller's Pathology of the Urine, 1855, p. 32; and Dublin Quarterly Med. Journ., 1855, vol. xx, p. 88.

Dead-born child.—The urine of a dead-born child examined by Hoppe[5] was found to contain only 3·26 parts per 1000 of organic matter (nature not stated), and 2·71 parts per 1000 of salts. It was therefore highly dilute.

New-born child.—The amount of urine in new-born children is not accurately known, so great are the difficulties of collection. It is small up to the third day, and is afterwards about 3 ounces daily (Hecker). In a case of Picard's it was 5 ounces (160 c.c.) on the sixth day. The reaction is almost, if not always acid; the colour pale yellow. There is in some cases (about 40 per cent.), and usually within the first fourteen days,[6] sometimes as late as the fortieth, a discharge of urates;[7] it is yet uncertain whether this is not pathological. Hecker is inclined to consider it so. Lecanu, Rayer, and (probably following him) Robin, and Verdeil state that the urine immediately after birth does not contain urea,[8] but this is certainly not constant, as Picard[9] found in the urine of a child five hours old 0·844 per cent. (!) of urea, and in seven other children from one day to five months old, from 0·27 to 1 per cent. Albumen and sugar were not noticed in any of Picard's cases.

In the urine of an eight-day-old child, Hecker[10] found 0·41 per

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[1] Dublin Quarterly Med. Journ., vol. xx, 1855, p. 88. Examined eight specimens of fœtal urine; sp. gr. 10085, blood and albumen were present; there was no urea.

[2] Stokvis, Canstatt's Jahresb. for 1856; Virchow's Report on Chronic Dis., Band iv, p. 351.

[3] Bernard refers the sugar in the urine of the fœtus to the same condition which causes the general diffusion of "glycogenic cellules" in the body, at a time previous to the action of the liver. When the liver begins its functions, the sugar disappears. (Comptes Rendus, 1859, No. 14, p. 679.)

[4] Op. cit.

[5] Hecker, in Virchow's Archiv, Band xi, p. 229.

[6] Hodann, quoted by Hecker.

[7] This is connected with the uric acid infarctus of the kidneys of new-born children, which has been lately carefully investigated by Hodann, Virchow, and Hecker.

[8] Rayer, Mal. des Reins. tome i, p. 61.

[9] Scherer's Report on Phys. Chem., Canstatt's Jahresb. for 1856, p. 171.

[10] Virchow's Archiv, Band xi, p. 231.

1000 of urea, 0·11 of uric acid, and no less than 6·14 per 1000 of other organic matter (some of the reactions indicated allantoin.) In another case, from the eighth to the seventeenth days, the proportions were—

Urea	2·84 per 1000.
Uric acid	0·31 ,,
ClNa	0·89 ,,
Sulphuric acid	0·24 ,,
Phosphoric acid . . .	0·06 ,,

Lime, soda, potash, extractives, and a little oxalate of lime were also present.

Young children (4 to 8 years).—Lehmann[1] states that the urine of children contains small quantities of phosphate but much sulphate; much hippuric but little uric acid.

Putting together the analyses of Scherer,[2] Rummel,[3] Bischoff,[4] and Lecanu,[5] I have calculated the following table; the mean age of the children was four years two months, and the mean weight was 31 lbs. The sexes are placed together:

	Total excretion in 24 hours. English weights.	1 lb. weight of body excreted in 24 hours. English weights.
Water	f℥xxiij	f℥vj
Solids	426 grains	13·7 grains
Urea	178·8 ,,	5·77 ,,
Extractives and vol. salts ...	60·7 ,,	1·96 ,,
Fire-proof salts	186·9 ,,	6·03 ,,

The following table, taken from Uhle, gives the amount in French weights according to the authorities quoted. It includes some of the analyses given in the above table, and adds those made by Uhle himself. In this table the analyses of Uhle[6] in three boys and two girls are compared with those given by Scherer, Mosler, Rummel, and Bischoff:

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[1] Lehrbuch der Phys. Chem., 2d edit., Band ii, p. 446.

[2] Würzburg Verhandl., Band iii, p. 180.

[3] Ibid., Band v, p. 116.

[4] Die Harnstoff als Maass des Stoffwechsels.

[5] Journal de Pharm., 1839, vol. xv.

[6] Schmidt's Jahrb., 1859, No. 10, p. 10; from the Wien Med. Zeitsch., 1859, Nos. 7—9.

Table from Uhle (amounts in cubic centimeters and grammes):

Boys.

Age.	No. of Cases and Authority.	Body weight in kilogrammes.	Amount in 24 hours.			Excreted by each kilogramme in 24 hours.		
			Urine.	Urea.	ClN	Urine.	Urea.	ClNa
3—5	2 Rummel—2 Uhle . . .	13·82	743	13·993	7·88	53·36	1·017	0·579
6	1 Mosler	15·5	1209	16·49	6·6	78·00	1·090	0·44
7	1 Scherer	22·42	1055	18·29	. .	47·06	0·811	. .
11	1 Mosler	24	1815	21·3	10·6	75·64	0·880	0·44
13	1 Uhle	32·69	756	18·81	. .	23·12	0·606	. .
16	1 Bischoff	48·91	742	19·86	8·8	15·30	0·408	0·180

Girls.

3—5	1 Scherer—1 Rummel—1 Uhle	15·07	707	14·649	6·907	47·55	0·978	1·569
16	1 Mosler	33	1601·	23·0	7·5	42·13	0·650	0·200
17	1 Mosler	46	1530	24·5	9·6	33·26	0·530	0·210
17—18	1 Rummel—1 Uhle . . .	59·62	834	22·498	8·16	14·32	0·358	0·140

The effect of sex below the age of eight would appear from these few observations to be imperceptible.

The analyses are as yet too few to completely determine the relative amounts of excretion in children and adult males; but the following table is probably near the truth.

Taking children (both sexes) between the ages of three and seven, it is found that each kilogramme of body weight excretes in twenty-four hours—

	In children.	In male adults.	Excess in children to each kilogramme.
Water	59 c.c.	23 c.c.	36 c.c.
Urea	0·973 grammes	0·500 grammes	0·473 grammes
Extractives and vol. salts	0·279 „	0·151 „	0·128 „
Chlorine	0·308 „	0·106 „	0·202 „

The amounts of the uric, sulphuric, and phosphoric acids, and of the bases, in children are so uncertain, that it would be an affectation of accuracy to include them in the calculation. In the above table it will be seen that healthy children under seven excrete almost twice as much urea in proportion to their weight as adults. After eight years of age the few analyses seem to show that the excess gradually lessens, until at about sixteen to eighteen years of age it reaches, or almost so, the excretion of adults.

The extractives appear from the above table to be also greater in children, though to a rather less extent than in the case of the urea. Scherer, from his analyses,[1] concluded that the extractives are deficient in the urine of children; and so they decidedly appeared to be, when his analyses of children and adults were compared. But on extending the observations, and taking in many more analyses in adults, and Rummel's analyses in children, it would appear that Scherer's statement is not correct on the large scale. He had placed the amount of extractives in the adults too high, and in the children too low; and it may at present be inferred that the extractives follow the same rule as the urea, and are greater in children, in a ratio a little below that of the urea.

The amount of chlorine to body weight in children is very great; nearly threefold the amount in an adult male.

Everything then shows a very rapid kidney elimination in children; and in these respects the kidneys only participate in the activity of the lungs (Scharling), and of the skin and intestines (Mosler).

The processes of construction and destruction in children are both very active; the tissues form rapidly, and almost as rapidly disintegrate. It is not till the period of complete growth is attained that a more quiet metamorphosis goes on.

In spite, however, of this rapid metamorphosis, oxalate of lime crystals are not uncommon in the urine of children; they occur in about 27 per cent.[2] in children between four and fourteen years of age.

Middle age.—Very few analyses of the urine in healthy men between forty and sixty years of age have yet been made. It seems probable, however, that the diminution in the excretion of urea, which is so marked in old age, is perceptible to a less extent all through middle life. We require, however, as many analyses as have been made in men between twenty and forty, to fix the exact rate of diminution. Perhaps we may provisionally assume, that the urea excretion proper to the individual will fall 5 per cent. between forty and fifty years of age, and 10 per cent. between fifty and sixty. The few analyses I have made have been in hospital patients, who had no great amount of disease. They show a greater lessening than I have just assumed, but then the men were on rather poor diet, and were comparatively inactive.

Commencing old age.—In men of sixty to seventy, the amount of urea is also smaller than in younger men. In one of Rummel's analyses,[3] in a man aged sixty-five, the water amounted to

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[1] Würzburg Verhandl., Band iii.

[2] Gallois, De l'Oxalate de Chaux, Paris, 1859.

[3] Würzburg Verhandl., Band v, p. 117.

2396·6 c.c., the urea only to 19·17 grammes; 1 lb. (Baien?) excreted, in twenty-four hours, only 0·184 gramme of urea.

More numerous experiments are, however, necessary on this point.

The water of the urine would appear, from the above analysis, to be less lessened than the urea; the amount of the other constituents must be considered undetermined.

Old age.—Few experiments have yet been made in very old persons (over seventy). Lecanu, in men of eighty-four to eighty-six years, found the urea greatly lessened; it amounted, on an average, only to 8·1 grammes, or 125 grains, in twenty-four hours. The phosphate of lime and the uric acid were stated, by Fourcroy, to be increased; but this is doubted by Rayer. In Lecanu's two old men, the amount of uric acid (mean of twelve days) was 0·546 and 0·190 gramme respectively; so that in one case there was no diminution, and in the other the amount is not much below that of some healthy adult men. Lecanu justly observes that the deposit of phosphates in old men is not owing to increase of earthy salts, but to lessening in the acidity of the urine of old persons.

Dechambre has stated that the urine of the aged is saccharine. If it be so occasionally, it would seem that there are many exceptions; even when it does occur, the amount of sugar appears to be very small.

SECTION III.

RACE AND TEMPERAMENT.

The effect of race cannot be decided till the precise influences of food and of different modes of life are accurately known, so that their effects may be eliminated from the problem. Taking only the German, French, and English (races which are, however, highly composite), it has been asserted that the urea and uric acid are least abundant in the French, are greater in amount in the Germans, and are highest in the English. I do not know on what comparative analyses this opinion is based, but, as Lehmann observes, if it be really true, it is probably owing to other causes, and not to any inherent differences of race.[1] It appears to be usually ascribed to the influence of the more nitrogenous diet supposed to be used by Englishmen.

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[1] Lehrbuch, 2d edit., Band ii, p. 444. Lehmann is not, however, aware that Prout and other English writers have believed Becquerel's numbers (which are very low) to be even too high for England. I believe the opinion mentioned in

At present no observations whatever have been made on the influence of temperament, and it is obviously an inquiry of the greatest difficulty. The effect of all the more appreciable conditions must be first determined.

SECTION IV.

WEIGHT.

As a general rule, the greater the weight of the body, the greater is the amount of the urinary constituents; and the reverse. This rule, however, is modified by many other influences, especially by age, sex, and food. Its general correctness is proved by taking persons of the same sex and age, and placing them under equal conditions of food and exercise; or, as has been lately done by Rudolph,[1] the influence of food may be excluded from the inquiry, by selecting fasting persons. It may be assumed, from Falck's observations, that the effect of food on the urine usually ceases in from ten to twelve hours; and the urine after that time represents merely the products of tissue change (*urina sanguinis*).

Rudolph took three men, of unequal weights, kept all the other conditions equal, and examined the urine during eleven fasting hours.[2] The following table gives the mean results:

	Weight of body in kilogrammes.	Quantity of urine in 11 fasting hours.	Quantity of urinary solids in 11 fasting hours.
R.	55	301 c.c.	12·786 grammes
G.	62·5	333 „	15·056 „
F.	82·7	490 „	22·440 „

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the text is simply owing to the general opinion held on the Continent, that the English are great feeders, and use large quantities of nitrogenous food.

Scherer (Würzburg Verhandl., 1852, Band iii, Sitzungsberichte, p. xix) also alludes to the "enormous quantity of urea in the urine of the much-flesh-eating Englishmen," and refers this to immediate formation of urea from the food. I have been unable to find any analyses bearing out Scherer's statements.

[1] De urina sanguinis, potûs et chyli. Henrico Rudolph. (Inaug. Diss., Marburg, 1854.)

[2] That is, he allowed twelve hours to pass, and then continued the examination during the next eleven hours; no food was therefore taken for twenty-three hours.

The increase with weight is thus clearly shown, and it is found to be steady enough in these three persons to admit of calculation. Thus, as R. excreted 12·786 grammes of solids, with a weight of 55 kilogrammes, what would the other two men have excreted had their tissue change gone on at the same rate as his? The answer is 14·528 and 19·225 grammes, which are not very far from the amounts actually excreted by these men.

The numerous isolated analyses made by different persons also show the effect of weight on the urea, modified, however, by other conditions. Heavy men, as a rule, excrete more urea than light men, but the increase does not seem to occur in the strict ratio of increase of weight. A single kilogramme does not excrete exactly the same amount in all persons. Thus, in men nearly of the same age, one kilogramme will excrete in one man 0·529 gramme of urea, and in another man only 0·420, and the differences may possibly be even greater, so that even if the two men were of the same weight, their ureal excretion would not be the same. Some analyses by Beneke[1] enable me to put this point rather more clearly, as the influences of age, food, exercise, &c., were all equal:

Name.	Age.	Weight in kilogrammes.	Amount of solid food.	Amount of liquid food.	Urea in 24 hours.	Urea to 1 kilo. in 24 hours.
			Grammes.	Grammes.	Grammes.	Grammes.
Ba ...	23	71·5	1286	1800	34·31	0·480
Ma ...	24	76·	975	1733	34·1	0·449
Mm ...	25	65·5	1102	1760	31·7	0·483

Here the age may be considered equal, but the heaviest man secreted absolutely less urea than a man weighing 4½ kilogrammes less, and relatively less than two men, one 4½, the other 10½ kilogrammes lighter. Can this be explained by his solid food being rather less in quantity; or was it rather less nitrogenous, or was the nitrogen, if the same in amount, excreted in another way?

In no other cases has the amount of food been determined; but the following table will show the general relation between weight and ureal excretion; the lightest weights are placed first. I have included Beneke's cases, some of my own, and one of Kerner's:

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[1] Nauheim's Soolthermen, 1859, p. 32, et. seq.

Ureal excretion in adult males.

Weight in kilogrammes.	Age.	Urea in 24 hours.	1 kilogramme excreted of Urea in 24 hours.
51·8	30	22·45	0·433
53·2	22	24	0·451
62·5	35	28·6	0·457
65·5	25	31·7	0·483
71·5	23	34·31	0·480
72	23	38·1	0·529
76	24	34·1	0·449

The increase according to the weight is thus certain, yet it is seen not to be perfectly regular.

It must also be admitted, that as the weight of the body is not dependent always on the same condition, but in one man may arise from large bones, in another from great development of muscle, in a third from fat, so its influence will be irregularly marked. The metamorphosis of bone is slow, and produces little or no urea; that of fat produces carbonic acid and water, that of muscle chiefly urea; so that a very heavy, bony, or fat man may have no great amount of ureal excretion, while a man of less weight, but more muscle, may have a large ureal flow.

The effect of weight on uric acid appears less marked (Ranke), and very heavy men sometimes excrete an extremely small quantity.

The influence on the sulphuric acid appears to resemble that on the urea. On the other constituents of the urine the experiments are not sufficient for any rule to be laid down.

SECTION V.

HEIGHT.

As far as at present known, height, apart from weight, has little influence. At any rate, the uric acid (Ranke), chlorine, sulphuric and phosphoric acid, are not influenced by it,[1] and no evidence has yet been obtained showing any effect on the urea, uric acid, or extractives.

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[1] Hegar, Gruner, and Winter, op. cit.

SECTION VI.

PULMONARY ACTIVITY.

The excretion of carbonic acid from the lungs is probably closely connected with the elimination of urea. At present, however, no accurate comparative experiments have been made in the same person, on the amount of these two excretions, except by Becher,[1] who observed a general relation between them, though their amounts were not always parallel. Thus both excretions are increased by food: but the maximum of the CO_2 was 2—3 hours; that of the urea, later, viz., 2—5 hours after food; and both were preceded by increased temperature of body, increased respiration and heart's action. It has been a favorite view, that lessened respiration (within physiological limits) diminishes the amount of urea, and increases that of uric acid, but there is no evidence at present on this point which can be considered quite satisfactory.

A few experiments have been made to connect the vital capacity (as determined by the spirometer) with the amount of urea, but they have not led to any result at present.

SECTION VII.

FOOD (SOLID).

The composition of the urine is more influenced by food than by any other condition, and it is of great importance for the practical physician to be fully aware of the extent to which it is so affected. Food acts in various ways; it supplies substances which become parts of tissues, or, on the contrary, pass out from the body as rapidly as they entered it; it causes a retardation or acceleration of metamorphosis according to its kind, or furnishes substances which enter the body only to be themselves metamorphosed by oxidation or fermentation.

Food is composed of different substances, which have different effects. The final result is, therefore, a consequence of very complex actions, and the several stages cannot be readily traced back.

I. ON THE INFLUENCE OF ORDINARY MEALS ON THE URINE.

About one or two hours (Chossat) after an ordinary meal of meat and vegetables, the urine begins to show the effect produced by food, and this effect usually continues for ten or twelve hours (urina cibi),[1] occasionally for sixteen or eighteen hours, and sometimes after a heavy meal for a still longer time.

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[1] "Die Kohlensaürespannung im Blute als propor. Maass des Umsatzes der Kohlenstoff. Korper. und Nahrungbestandtheile." Henle's Zeits., 1855, p. 249 et seq.

1. The water.—If some fluid be taken as usual with food, the amount of urine increases in the second or third hour, and the increase continues for ten hours. Taking the mean of a great number of observations by Vogel, Winter, Gruner, Mosler, and myself, I find the increase to be nearly one third (from about 60 to 90 c.c. per hour). But the result is necessarily influenced so much by the kind of meal, and the amount of fluid taken, that the rule is subject to many exceptions. In some cases I have found the urine lessened for some hours after a usual meal; Chambert[2] found it always lessened; and Beneke, from a most elaborate series of investigations, has declared that no rule can be laid down. But this is exaggerating the uncertainty of the point.

2. The solids are always increased, though the time of commencing increase is variable (one to four hours after food). The amount of increase varies. J. Vogel in one case made it about one fifth (from 2·5 grammes in a fasting hour, to 3·2 grammes in a food hour). Rudolph, on taking equal periods of ten hours, found the mean increase to be more than double in the food hours (as 2·371 is to 1).

3. The urea.—Of the various solids, the urea is uniformly augmented. It commences to increase even during the first hour,[3] and attains its maximum sometimes in the third (Becher),[4] sometimes not till the seventh hour after food (Voit). Usually, after the fourth hour it begins to fall, and returns to the standard of inanition generally by the tenth; but sometimes traces of increase can be found till the sixteenth hour after food (Voit), and even sometimes longer. The amount of increase varies; I have found it more than doubled (from 0·665 grammes in a fasting, to 1·554 grammes in a food hour).

As already noticed in the Introduction, the increase in the urea so soon after food has given rise to the famous controversy between Schmidt and Bidder, Frerichs and Lehmann, on the one hand, and Liebig and Bischoff on the other, as to whether some portion of the food is at once converted partly into urea

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[1] The effect of food on the urine has been described by many older writers, especially by Nysten (Recherches de Phys. et de Chim. Path., Paris, 1811), and Chossat (1815).

[2] Lehmann, Lehrb. der Phys. Chem., 2d edit., Band ii, p. 443.

[3] Voit, quoted by Meissner, Report on Phys. for 1857, Henle's Zeits., 1858, p. 352.

[4] Henle's Zeitsch., 1855, p. 249.

(luxus-consumption of Bidder and Schmidt), or whether it merely causes a vast increase in the rapidity of tissue change, by the increase in the rapidity and force of the circulation, by the action on the nervous system to which it gives rise, or by an immediate chemical action on tissues. To reconcile these different views, F. Fuhrer and H. Ludwig[1] suggested, some time ago, an intermediate view, viz., that the increase in the urea is not owing to direct transformation of food, or to increased metamorphosis of the solid tissues, but to increased disintegration of blood-cells. The point is one of great importance in practical medicine.[2] If urea be formed direct from food, it ceases, of course, to be a measure of tissue change except during fasting hours; and if during health, some portion of food is thus eliminated as urea, without taking any part in the formative processes of the body, it is quite possible that, in disease, the same thing might go on to a still greater extent, and that even the whole of the nitrogenous nourishment might emerge as urea without forming, even for a time, a component part of any tissue. It is conceivable, indeed, that there might be a large discharge of urea from directly metamorphosed food, with an absolute lessening in tissue destruction.

However, the latest observations of Bischoff and Voit,[3] already referred to in the Introduction, seem to have almost settled the controversy, and to have proved that urea is always a product of tissue metamorphosis, and that, in flesh-feeders at any rate, it is an exact measure of this.

4. Creatin and creatinin.—Nothing is known of the effect of food on these substances.

5. Pigment and extractives. — Although the amount of urine often increases, the colour of the urine generally deepens; and it is, therefore, to be inferred that the amount of pigment is augmented; but no analyses have yet been made. The effect on the "extractives" is uncertain.

6. Uric and hippuric acids.—Uric acid is stated by Funke to be less affected by food than any other ingredient.[4] Bence Jones[5] and Ranke,[6] however, have indubitably proved that it

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[1] Archiv fur Phys. Heilk., 1855, p. 215.

[2] The statement of Bechamp (Essai sur les substances albuminoides, et sur leur transformation en Urée. Strasbourg, 1856), that urea can be formed directly from albumen, seemed to strengthen the doctrine of a luxus-consumption, but Staedeler (Journ. für Prak. Chem., 1857, Band lxxii, p. 250) has refuted Bechamp's assertion. He could not form urea, but he obtained benzoic acid (mistaken for urea), formic and acetic acids.

[3] Die Gesetze der Emährung des Fleischfressers, 1860.

[4] Funke, Lehrb. des spec. Phys., 1854, p. 357.

[5] Phil. Trans., 1849, p. 251. Bence Jones gives only the per-centage amounts but these make his conclusion very probable.

[6] Ausscheidung des Harnsaure, p. 9.

does increase after food. The exact kind of food (as long as it is nitrogenous) appears to be of comparatively little moment. Sometimes, in the urina cibi, sediments of urates fall; but this is certainly often simply owing to lessening of water, and sometimes to increase of free acidity. When the food is imperfectly digested, Prout thought the uric acid was increased; but here also sufficient attention was not paid to the amount of solvent of the urates, and the point is still uncertain.

The variations of hippuric acid, after food, have not been directly determined.

7. Sulphuric acid is usually increased in the second hour after food, and the increase continues for six or eight hours. I have found the difference between a fasting and food hour to be as one to two, nearly (from 1·1 grain per hour to 2·1 grains per hour). The mean of Gruner's analyses gives rather a less amount, viz., from 0·065 grammes, or 1·036 grains, in each fasting hour, to 0·097 grammes, or 1·5 grains, in each food hour. From Buchheim's observations[1] it may be calculated, that in two healthy young men, about one third of the SO_3 excreted in twenty-four hours came directly from the sulphates of the food. This is almost exactly the proportion in my own cases. Sometimes the SO_3 is not increased by food.[2] The cause of this is uncertain; the food must have been deficient in sulphates, or these were retained. The sulphuric acid, as it is in part derived from the sulphates of the food, is clearly not a measure of metamorphosis, except during inanition hours.

8. Phosphoric acid.—Both the alkaline and earthy phosphates are increased, and especially the latter (Bence Jones and Beneke). The increase commences soon after food, and lasts for about nine hours (Winter). The amount of increase is, on an average, about one fifth (Mosler).

9. Chlorine.—The chlorine is increased, but not unusually till the fourth hour. I have sometimes found it lessened during the first three hours, when digestion is so active, and then excreted largely afterwards. Buchheim,[3] however, states that the increase of the chlorides is prior to that of the SO_3. Hegar[4] observes, that sometimes a part of what is taken is excreted rapidly, while a part is retained for a longer time. The quantity finally emerging by the urine does not, in men, quite equal that which is taken as food; some part passes off by another channel, probably by the skin, as traces only are found in the intestinal discharges.

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[1] Vierordt's Archiv, 1854, p. 93.

[2] Gruner and Clare.

[3] Vierordt's Archiv für phys. Heilk., 1854, p. 93.

[4] Op. cit., p. 23.

10. Bases.— The potash, soda, lime, and magnesia are all increased, in proportion, apparently, to their acids; or it might be more correct, perhaps, to say, that sometimes, at any rate, the acids (sulphuric, phosphoric, and perhaps uric) are increased in proportion to their bases.

11. Acidity of the urine.—Much controversy has taken place on this point. Dr. Bence Jones, many years ago, concluded from numerous experiments, that the acidity lessened during digestion, and sometimes was even replaced by alkalinity (from free alkali). This statement has given rise to great controversy.

Winter's results are not quite accordant:[1] he found the acidity least after breakfast; greater after dinner, at one o'clock; greatest during night—

	Grammes of crystallized oxalic acid.
In every hour after breakfast it was equal .	0·0782
„ „ dinner	0·0997
„ during night	0·1125

These experiments, and others of the same kind, are considered by Vogel as unfavorable, though not absolutely contradictory, to Bence Jones's statement. Beneke, however, who has made experiments during more than one hundred days on himself, rarely found diminution of acidity after meals, and denies altogether the influence of food. Delavand[2] found the urine most acid before breakfast; neuter after breakfast; acid in the night. Dr. Sellers[3] doubts the general applicability of Dr. Bence Jones's rule, without, however denying that food has some effect on the acidity. An elaborate and apparently conclusive series of experiments has been made by Dr. Roberts, of Manchester.[4] The urine was examined every hour, or every two hours, after meals of various kinds, and the result entirely confirmed Bence Jones's statement. Food, without exception, lowered the acid reaction of the urine. The method which was adopted in these experiments, the care with which they were performed, and the length of time over which they lasted, renders this investigation by far the most satisfactory yet carried out; and it may, I believe, be now considered that Bence Jones's statement is quite confirmed. It must also be said, that the experiments of both Winter and Beneke were badly planned, for the urine was not examined at sufficiently short periods; and therefore much weight cannot be attached to their opinions.

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[1] Op. cit., p. 23.

[2] Gazette Médicale, 1851, No. 44.

[3] Edinb. Med. Journ., Jan., 1859.

[4] Memoirs of the Literary and Philosophical Society of Manchester, 1858-9, vol. xv; and Edinburgh Medical Journal, 1860.

Dr. Hermann Weber has kindly communicated to me the results of some experiments on himself, which agree in great measure with those of Winter, and form an important addition to our knowledge on this point. Urine was neutralized with solution of carbonate of soda, containing 6 grammes to 1400 cubic centimetres of distilled water.

The day was divided into five periods.

Acidity per hour, as expressed by a certain number of cubic centimeters of an alkaline solution.

	Mean quantity of soda solution required.	Largest quantity required.	Smallest quantity required.
From 7 a.m. to 8 a.m.—No food; cold bath and glass of cold water. Urina sanguinis	9	15	2
From 8 a.m. to 1 p.m.—Breakfast at 8 a.m.; some exercise. Urina cibi	5·88	15	0
From 1 p.m. to 8 p.m.—Dinner at 1, meat, potatoes. Urina cibi ...	5·6	18	very slightly alkaline.
From 8 p.m. to 11 p.m.—Tea at 8; bed-time at 11. Urina cibi ...	8	22	0
From 11 p.m. to 7 a.m.—Sleep hours. Mixed urina cibi et sanguinis ...	9·12	14	4·8

These experiments extended over a period of two months.

It would thus seem that during the night there was greatest acidity, with less violent variation, than at other times; and Dr. Weber noticed this, not only when he slept well, but, on some occasions, when he did not go to bed till 3 a.m., and also, on some occasions, when he rose at 4 a.m. The increase was, therefore, independent of sleep. It was so far connected with food, that it was greatest when the stomach was least active; and to this extent Dr. Weber's experiments agree with Dr. Bence Jones's.

Breakfast decidedly had an influence in lowering the acidity; yet Dr. Weber noticed that when he went without breakfast, the acidity still lessened, though not to so great a degree.

After dinner, the decrease may be attributed in part to food; when no dinner was taken, the decrease was less, yet the amount even then, although there was perfect fasting, was never so high as during the night. Sometimes, even after dinner, there was an intense acidity, greater than even during the night, as will be seen on reference to the table. The evening tea did not lower the acidity.

The influence of food here appears decided; and Weber's experiments are not discordant with those of Roberts.

In some persons Dr. Weber has found results accordant with the observations on himself, while in others the experiments gave quite contrary results, and the acidity of the urine was found to be absolutely increased by food. This may, perhaps, be accounted for by occasional indigestion, and increased production and rapid elimination of acid; but exact experiments are still wanting.

The time when the acidity was most lessened, in Roberts' experiments, was in the second hour after breakfast, and in the third, fourth, and fifth hours after dinner.

The effect of mixed and pure animal diet was identical; vegetable food had a feeble effect at first, but when used for several days, its action was equally powerful. The solids of the urine were found, by Roberts, to increase simultaneously with the lessening of the acidity.

The lessened acidity of the urine from food is not owing to ammonia, but to fixed alkalies. Dr. Bence Jones supposed that it was to be explained by the blood becoming more alkaline during digestion, on account of the quantity of acid then poured into the stomach. Dr. Roberts suggests that it is simply owing to the increased ingress of alkali in the food. And certainly it would seem that, as a rule, the bases are in excess over the mineral acids in ordinary food. It is obvious, however, that more minute chemical determination of the relative amounts of acids and alkalies in food is requisite to settle the question. It is certain, at any rate, that fixed alkali is not formed in the body; so, to render the urine alkaline, there must be either increased introduction of alkali, or dislocation of it from its usual acid. Both causes may be in play.

Although the immediate effect of food is thus to lessen the acidity, the remote effect is to increase it; *i. e.*, food increases the chemical changes in the body, and these changes give rise to acids. (SO_3PhO_5, uric, hippuric, &c.)

12. Sediments.—Sediments of urates frequently occur in the urina cibi, partly from lessening in the amount of water, partly from increased amount of uric acid. On the other hand, if the acidity of the urine falls to a certain point, the amorphous earthy phosphates precipitate as a matter of course. Neither of these sediments can be considered morbid; they sometimes occur together.

13. Abnormal constituents. — The occurrence of albumen, sugar, and fat, after meals, is considered at a subsequent page.

II. On the Influence of Special Kinds of Food.

1. *Nitrogenous* (*animal*) *Food.*

The well-known observations of Lehmann[1] have been fully confirmed by Bidder and Schmidt, Bischoff, V. Franque, Becher and Pettenkofer, and others.

1. The water is increased, especially if the diet be pure albumen (Böcker[2]), although no fluid is taken. This has been attributed to the influence of the nitrogenous food on the nervous system; may it be owing, simply, to the heightened production of urea?

2. Urea is much increased. Taking the normal amount of urea as 1, animal food increased it to 1·43 (Lehmann); 100 grammes of pure albumen augmented the urea from 5·7 to 7·6 grammes in 6 hours (Böcker). The increase in the urea appears at present to be proportionate to the nitrogen introduced, when the body does not gain weight. More analysis, in men, however, are necessary to make this point quite certain.[3]

4. Creatin and creatinin.—Nothing is known under this head.

5. The pigment and extractives are much lessened (more than one third, Lehmann). The cause of this is unknown.

6. The uric acid is also increased, though less relatively than the urea; taking the healthy amount as 1, animal food increases it to 1·27 (Lehmann). The experiments of Ranke[4] show an increase in nearly the same proportion, viz., from 1 to 1·4. Very indigestible food, such as cheese, or vegetable food containing much nitrogen, have been supposed especially to augment the uric acid.

7. Hippuric acid is much lessened by animal food, and sometimes is said to disappear; though this is denied by Weismann, who never found it entirely absent. Hallwachs also, when chiefly on a meat diet, excreted daily 1 gramme of hippuric acid (weighed before purification).

8. The sulphuric acid is much increased, partly on account of the increase of sulphates introduced, partly, perhaps, from increased

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[1] Lehrb. der phys. Chem., Band ii, p. 447. For a very accurate account of Lehmann's experiments, see Day, in Simon's Chem. of Man, vol. ii, p. 156.

[2] Böcker, Archiv des Vereins für wiss. Heilk., Band ii, p. 281. Bidder and Schmidt noticed a similar increase in cats. One of Voit's observations is partly confirmatory, though the food was not taken quite water-free.

[3] In dogs, the urine is exactly proportionate to the nitrogen introduced; the increase in the urea is sometimes enormous. Bischoff noticed that a dog, which, on 1200 grammes of meat, gave daily 88 grammes of urea, passed 181 grammes on 2660 grammes of meat. Without food, the same dog passed 12 grammes of urea. In order exactly to keep equal the weight of the body, a dog requires from one twentieth to one twenty-fifth of his weight in flesh. Bischoff and Voit, Die Gesetze der Ernährung des Fleischfressers, 1860.

[4] Ausscheidung der Harnsaure, p. 9.

oxidation of the sulphur. Bischoff and Voit have also noticed that the unoxidized sulphur in the urine is greatly increased in dogs, so that some of the surplus sulphur passes out in the same form.

9. The phosphoric acid is greatly augmented, even to double, by albumen (Mosler); the earthy phosphates are relatively more augmented than the alkaline. The augmentation is no doubt chiefly owing to greater ingress of phosphates. There may also be increased oxidation of phosphorus. Whether the unoxidized phosphorus is increased is not yet known.

10. The chlorine is much lessened (Lehmann and V. Franque) owing to the lessened quantity which is introduced in animal food.

11. The free acidity, lowered at first, is eventually increased, from the augmentation in the uric, phosphoric, and sulphuric acids, as no fresh or unusual acid has been indicated in the urine.

12. Abnormal constituents.—A diet entirely composed of eggs gives rise in many persons to albuminuria. (See Introduction to Part II.)

The importance of bearing these facts in mind, when the urine of disease is examined, is obvious. In some diseases, as in diabetes mellitus, a strict animal diet is often enforced, and the large amount of urea and sulphuric acid which is sometimes found in this disease may be attributable to the diet alone. In fevers, too, the diet is often highly nitrogenous, and some portion of the large amount of urea found in these cases may be owing to this.

2. *Non-nitrogenous Food.*

1. The water is lessened (V. Franque).

2. The urea greatly lessens. Taking the normal excretion as 1, a starch and sugar diet lessens the urea to 0·474, or more than one half (Lehmann). This depends in great measure on the lessened ingress of nitrogen, but also on an appropriation by the non-nitrogenous food of the oxygen necessary for the metamorphosis of the nitrogenous tissues. (See "Fat" and "Sugar.")

3. The "extractives" are increased one third (Lehmann). The cause of this is uncertain.

4. The uric acid is lessened nearly one half. If the normal excretion be as 1, the amount falls to 0·63 (Lehmann). The amount of hippuric acid is uncertain.

5. The sulphuric acid, phosphoric acid, and chlorine are probably lessened, but exact analyses are still wanting.

6. The free acidity lessens, and the urine may even become alkaline (V. Franque).

When the diet is not entirely non-nitrogenous, but when to an ordinary diet a non-nitrogenous substance is added in excess, the following changes occur:

(*a.*) *When fat is added in excess to ordinary diet.*

If taken in large quantity, or for a long time in small quantity, the fat of the urine increases.[1] Lang has noticed an increase from 0·077 grammes to 0·200 of the dried solids.[2]

The latest experiments of Bischoff and Voit[3] on dogs have apparently explained the effect of fat. Three great factors (in addition to the nerves[4]) govern the nutrition of a tissue, viz. the tissue itself, which acts according to its bulk, the nitrogenous plasma necessary for its indispensable continued movements, and the oxygen. From the attraction of the tissue for the plasma, and of the oxygen for the products formed by the metamorphosis, result the chemical changes which we recognise as construction and destruction. How these factors mutually react, and balance each other, has been beautifully explained by Bischoff. When a dog is fed on flesh alone, tissue change is much heightened; the urea increases, but, owing to the gradual consumption of oxygen, a limit is put at last to the metamorphosis. The animal then refuses to eat. For the loss of the attractive force of the oxygen for the excretory products (the urea in dogs) diminishes, *pro tanto*, the attraction of the tissue for the plasma, and metamorphosis lessens until all the effete products having been oxidized and removed, more oxygen is available to contribute again the force necessary to enable the cycle of changes to take place.

Now fat does not prevent the metamorphic changes produced in tissue by flesh-feeding, nor does it hinder the increase of metamorphosis when flesh is given in excess; on the contrary, if a very large quantity of flesh be given to dogs, and fat at the same time, all the oxygen is taken up in oxidizing the excretory products of nitrogenous metamorphosis, and the fat, instead of being oxidized, is stored up in the body. But if a less quantity of flesh be taken (an amount not large enough quite to cover all the loss which takes place in the disintegrating tissue), then the fat plays this important part,—it is oxidized, and therefore diminishes the amount of disposable oxygen; but in diminishing this amount, it of course lessens, *pro tanto*, the attractive force of the oxygen for the excretory products, and thus one of the factors of tissue metamorphosis is depressed, and a portion of the tissue, which would otherwise be destroyed, is not so. So that if fat be added to flesh, a smaller quantity of flesh maintains the body at an equal weight than if no fat were present; for the limit where oxygen ceases, by its attraction for the excretory products, to augment the metamorphosis of the nitrogenous tissues, is sooner reached.

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[1] Lang, "De adipe in urina et renibus hominum et animalium," Inaug. Diss. Dorpat, 1852.

[2] Mettenheimer, Archiv des Vereins, Band i, p. 374.

[3] Die Gesetze der Ernährung des Fleischfressers, 1860. The result of the experiments are somewhat different from those in Bischoff's former work, Harnstoff als Maass des Stoffwechsels.

[4] That the influence of nerves on nutrition and secretion is enormous, is becoming more evident every day. In disease, the perturbations caused by the changes in the nervous currents are more marked than in health.

But in addition to this effect which arises from fat preventing the action which the presence of oxygen would exert on the tissues, fat has another and contrary effect. Bischoff believes that it is not burnt off in the blood (as sugar is), but enters into the tissues and undergoes certain changes before it is oxidized. In thus entering into the tissues (into the liver?), it is substituted for the nitrogenous molecules, and augments the metamorphosis of that tissue.[1]

If the action of fat be as Bischoff supposes—and he appears to have given abundant experimental proof—it is clear that in men on good diet, an excess of fat will simply be stored up in the body, and will not be likely to cause any lessening of the urinary excretion, though it would, of course, do this in starving or ill-fed persons, to some extent.[2]

The most complete experiments on men are by Dr. F. W. Böcker.[3] From very elaborate and long-continued experiments on four healthy young men who used first a diet without butter, and then one with a varying quantity of butter (from 2 to 90 grammes), Böcker concludes that no influence whatever can be proved to have been exerted by the fat diet on the water, the urea, uric acid, sulphuric acid, phosphoric acid, magnesia, soda, or potash of the urine. His experiments seem certainly very conclusive, and are in accordance with Bischoff's views.

(*b*.) *When sugar is added in excess to ordinary diet.*

The experiments of Bischoff and Voit on dogs (already referred to) have shown, that in flesh-feeders sugar has the same effect as fat, but in a higher degree, as it at once combines with oxygen in the blood, and does not enter into tissue combination, as fat is supposed to do. It will not hinder the necessary metamorphosis of tissue—that metamorphosis which is their life, nor does it prevent the increase in the urea (increase of metamorphosis, according to Bischoff) in excessive flesh-feeding; but by furnishing a substance for the oxygen to act upon, and thereby lessening, as fat does, the attractive force of oxygen for the tissues, it lessens the necessity for nitrogenous food, and a much smaller quantity of this food suffices for the equalization of construction and destruction of tissues, *i. e.* for maintaining the body at an equal weight. So also, by its easier oxidation, sugar spares the consumption of fat, whether it be the fat already in the body or that of the food. But, in flesh-feeders, Bischoff questions whether it is converted into fat. The tendency of persons who take large quantities of sugar to get fat is well known, but possibly this is merely from lessened destruction of fat.

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[1] "Fat has then a double action; by means of its carbon and hydrogen, it appropriates the oxygen of the blood, and thus lessens the exchange of tissue; only it increases this exchange directly in another mode, for it evidently, in some way, enters into this tissue change before its elements combine with oxygen. The first action is, however, greater than the second; therefore the general effect is always a depression of nitrogenous metamorphosis." Bischoff and Voit, Die Gesetze der Ernahrung, p. 178.

[2] Botkin has endeavoured to show that the urea in dogs is much lessened. The average amount, when 1 lb. of meat and 220 c.c. of water was given as food, was on an average 31·96 grammes; when 81 grammes of fat was added to this diet, the urea sank to 24·3 grammes. The weight of the animal augmented greatly, from lessened elimination of nitrogen. (Virchow's Archiv, Band xv, p. 380.) Botkin has pointed out that, in his early experiments, Bischoff did not give his dogs the same quantity of water in his comparative experiments; so that there is an important fallacy. But Bischoff's later observations are free from this fault.

[3] Œsterlen's Zeitschrift für Hygieine, Band i, 1859, p. 1.

In men the facts hitherto acquired are not altogether accordant with this view, but none of them are worthy of being put on a level with Bischoff's experiments on dogs, in point of correctness and extent.

In Men.—When taken in large quantities, sugar can be detected in the urine[1] of men.

1. The water increases, although none enters the body (Beneke).[2] Roberts noticed in one case a great diuresis after a large dose of cane sugar. This is probably owing to the great attraction of sugar for water; it drains the body of water. There is as yet no proof that the excess of water is formed in the body. (See "Diabetes.")

2. The urea is lessened, according to Böcker,[3] to a great extent. Böcker found in nine days a diminution to the extent of no less than 94·2 grammes, or 1404 grains.[4] The decrease is so great as to have created doubts of the correctness of the experiments, and certainly it is very desirable they should be repeated. Bischoff's experiments are rather antagonistic. The observations of Hoppe on dogs[5] may, however, be quoted in support. When dogs were fed on meat alone, and took, in seven days, 88·305 grammes of nitrogen, there passed off—

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[1] Hegar, while taking ¾ lb. of sugar daily, clearly detected it in the urine. (Zur Wurdigung der phosphorsauren Erden, Archiv des Vereins, Band ii, p. 420.) Bischoff has noticed it in the urine of the dog fed on sugar.

[2] Nord-See Bad., p. 31.

[3] Beitrage zur Heilkunde. Crefeld, 1849, vol. i, p. 67.

[4] There was a coincident reduction in the amount of pulmonary CO_2.

Virchow's Archiv, Band x, p. 144.

With the urine . . .	66·98	grammes of nitrogen.
„ fæces . . .	7·656	„ „
By other ways . . .	13·668	„ „

When in another seven days 86·426 grammes of nitrogen were taken, but, in addition, sugar was also given, there passed off—

With the urine . .	41·178	grammes of nitrogen.
„ fæces . .	6·345	„ „

The animal increased in weight much faster with than without the sugar.[1]

3. The effect on the extractives is unknown.

4. The uric acid is lessened (Böcker). The amount of the hippuric acid is unknown.

5. The sulphuric acid is probably lessened by sugar, but further experiments are needed.

6. The phosphoric acid is certainly lessened; for the independent experiments of Böcker and Hegar agree on this point. Böcker indeed holds that the lessening of this acid, and especially of the phosphate of lime, is the most marked effect of the sugar. In nine days there was a retention in the body of no less than 9·46 grammes, or 147 grains, of phosphate of lime; an almost incredible amount.[2] This must have resulted either from retarded metamorphosis of bony or of some other tissue, in which the earthy phosphates enter largely, or the phosphate of the food must have been retained in the intestinal canal by some new combination formed there. Of this, however, there is not the slightest proof.

7. The effect on the chlorine is not certain; if the usual quantity be taken, it is probably excreted as usual.

8. The acidity is not, according to Roberts,[3] lessened by cane sugar and honey.

(c.) *When starch food is added in excess to ordinary diet.*

The effect of starchy food is probably the same as that of sugar, but no experiments on them have yet been made[4] on men. Bischoff and Voit, however, have proved that in dogs the same effects are produced by starch as by sugar.

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[1] Hoppe discusses very ably the form in which the nitrogen was retained. He also believes that the sugar in the blood limits the oxidation of the albuminous substances, and he thinks these then undergo fatty degeneration.

[2] The employment of sugar in rickets and mollities ossium at once suggests itself, if these experiments are confirmed. If sugar forms lactic acid, as generally believed, it is plain that this acid has no effect in dissolving the earths of the bones, as has been suggested.

[3] Op. cit., p. 59.

[4] The careful observations of Lawes and Gilbert on the fattening of animals seem also decidedly to show that the starch foods save the protein food from too rapid destruction. (Journal of the Royal Agricultural Society, 1854.)

3. *Vegetable Food.*

Ordinary vegetables, taken as the sole food, produce the following effects:

1. The water is sometimes unaltered, sometimes increases, especially when potatoes are largely used (Beneke.)

2. The urea lessens; the normal excretion being taken as unity, vegetable food reduces it to 0·686 (Lehmann). This is attributable to the lessened amount of nitrogen usually present in vegetable food. The experiments of V. Franque, Warnecke, Haughton, and others, agree tolerably closely with the rule deduced from Lehmann's observation, though, on the whole, the diminution is a little less, viz., from one fourth to one fifth.

3. The pigment, and the "extractives" generally, are considerably increased.

4. The uric acid is lessened, in the proportion of from 1 to 0·887 (Lehmann). Ranke's observations imply a less effect than this; in fact, one day of almost pure vegetable diet gave as much uric acid as in health. Still, when the vegetable diet was continued, the mean excretion in Ranke was 0·650 grammes, as against 0·880 on flesh diet.

5. The hippuric acid is largely augmented, although no benzoic acid or benzoyl compound be introduced. According to Weissmann, this augmentation is not owing to vegetable albumen or starch, but to lignin. It is not owing to chlorophyll (Hallwachs).

6. The sulphuric acid is variously effected; is usually lessened, owing to lessened ingress of sulphur and sulphates.

7. The phosphoric acid is also lessened from the same causes.

8. The chlorine is very largely increased (V. Franque), from the increased quantity introduced in vegetable food.

9. The bases are augmented, especially on account of the greater introduction of chloride of sodium.

10. The free acidity is lessened, and the urine is often alkaline. This can even be produced by potatoes (Owen Rees and Beneke).

11. Lactates and benzoates have been said to be present in the urine of vegetable-feeders, but it is probable that hippuric acid was mistaken for benzoic.

12. Owing to the lessened acidity, deposits of the phosphates of lime and magnesia are common. The deposits are usually amorphous or globular. It is said that an increased amount of crystals of oxalate of lime is seen after the use of many vegetables, especially after leeks, onions, turnips, parsnips, and carrots.[1] Sorrel and rhubarb have this effect in a still greater degree, and so, it is said, have tomatas.[2] Whether the oxalate of lime is at

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[1] Rose, Medical Gazette, 1850.

[2] Willis, Urinary Diseases, p. 118.

once derived from these vegetables, and merely passes unchanged through the body, or whether they cause some delay of metamorphosis, is unknown.

A curious statement is made by Gallois,[1] that though sorrel at first causes the appearance of much oxalate of lime, this effect lessens if the sorrel be continued as food. It seems as if, in some way, the acid was after a time destroyed.

Cauliflower and asparagus give rise to few crystals of oxalate of lime. Both these vegetables give very rapidly a nauseous odour to the urine. Asparagus in large quantity will produce, in some persons, temporary glucosuria;[2] the water is sometimes increased, and the tincture has been recommended as a diuretic by Jeaffreson, of Leamington.[3] The colouring-matter of some vegetables, as beet-root, passes into the urine.[4]

Fruits.—The effect of fruits on the composition of the urine has not yet been made out; as far as known, they appear to have the same effect as other vegetables.

Wohler[5] noticed that the urine became alkaline after the copious use of cherries, apples, and strawberries, on account, it was supposed, of the conversion of the acetates and citrates into carbonates. Höfle[6] could not make his own urine alkaline with 1 lb. of grapes and 16 oz. of black cherries; but Wöhler's statement is correct for most persons.

Any vegetable containing benzoic acid or a benzoyl compounded (as some kinds of plums) gives rise to hippuric acid, just as if benzoic acid were taken.[7] Apples, pears, and other customary fruits, do not have this effect.

The colouring-matter of bilberry,[8] and of several other fruits, pass into the urine.

4. *Special Articles of Diet.*

1. *Gelatine.*—Gelatine does not pass off in the urine, but is entirely destroyed. The amount of urea is greatly increased,[9] and this is generally supposed to occur from direct oxidation in the blood.

In being thus oxidized, gelatine appropriates oxygen, which would otherwise act on tissues, and thus, like fat and sugar, lessen the metamorphosis. But Bischoff, from his last experiments, questions whether it does not play a more important part than this; whether, in fact, it does not enter into the composition of the tissues, and thus take, in part (one fourth), the place of albumen. For the figures relied on in support of this, I must refer to Bischoff's work on 'The Laws of Nutrition in Flesh Feeders' (p. 215 et seq.).

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[1] De l'Oxalate de Chaux. Paris, 1859.

[2] Harley, British and Foreign Med.-Chir. Review, July, 1857, p. 199.

[3] Assoc. Med. Journal, 1855, May.

[4] Höfle, Chem. und Mikroskop. am Krankenbette, 1st edition, p. 333.

[5] Tiedemann's and Gmelin's Zeitschrift, Band i, p. 144.

[6] Chem. and Mikrosk. am Krankenb., 1st edition, p. 331.

[7] Duchek. Prag. Vierteljahrsch., 1854, Band iii, p. 25.

[8] Höfle, op. cit., p. 331.

[9] Boussingault. Frerichs, Wagner's Handworterbuch, Band iii, p. 640. Lehmann, Handbuch der Phys. Chem., 1st edit., 1854, p. 183. Bischoff and Voit, Die Gesetze der Ernährung, p. 240 et seq.

In either case, the practice of giving strong jellies in fevers, and in cases in which it is wished to arrest metamorphosis, is sound; for either gelatine[1] is a true aliment, or, if not, it is an absorber of oxygen, and thus limits metamorphosis. The effect of gelatine on the other constituents of the urine is not known.[2]

2. *Chloride of Sodium.*—Chloride of sodium in large doses is rather a medicine than an article of diet; yet there is an advantage in considering its effect under this head.

Although it is probable that chloride of sodium is to some extent decomposed[3] in the system (Prout), this point has not been worked out; and it is assumed that, even if separated, the base and acid eventually reunite, and emerge from the body in the same combination as that in which they entered.

The whole of the chloride of sodium taken with ordinary meals does not pass out with the urine; a portion of it soon emerges (within six hours[4]); another part is retained for some time, and then appears in the urine: so that in twenty-four hours two thirds have passed out, while a considerable amount (one third, Bischoff) never appears in the urine at all, but is either retained for a longer time, or emerges by the skin or, if there be diarrhœa, by the intestines, or occasionally by the saliva (Percy, Wright), or by the milk during suckling (Harnier).

Kaupp[5] makes the mean difference between ingress and egress (by the urine) about one fourth in men. The relative difference is, however, less when the quantity is small than when it is large. Kaupp is inclined to believe that some of the chloride is strongly retained by the body.[6]

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[1] Bischoff's facts open again the apparently interminable discussion on the value of gelatine as an aliment.

[2] In determining the amount of urea in fevers, it must be remembered that gelatine increases the urea. I am sure some analyses are vitiated by this fallacy.

[3] It is, perhaps, decomposed by even feeble acids, when albumen is present. See paper by author, in the Medical Times and Gazette, 1850.

[4] Buchheim, Vierordt's Archiv, 1854, p. 93.

[5] Beitrage zur phys. des Harns, von W. Kaupp. Vierordt's Archiv für phys. Heilk., 1855, p. 385.

[6] In dogs, Bischoff formerly thought that only a certain quantity could be recovered from the urine, but his later experiments have shown that all passes out through the kidneys in dogs. (Ernährung der Fleischfressers, p. 276.) Yet the good effect on the nutrition of the skin in cattle (Boussingault) makes it probable that in them some of it passes off by that channel.

1. The urinary water is not increased, is even lessened, in man (Kaupp and Falck[1]). It is increased in dogs (Bischoff). If diarrhœa is produced by the salt, the urinary water is much lessened.

2. The urea is scarcely, if at all, increased in men. Taking the mean of very numerous experiments by Kaupp on himself, the following table will show the result of seventy-two days' experiments on a regulated diet—

	Daily excretion of urea.
Mean of thirty-six days, the quantity of chloride of sodium taken daily being 28·7 grammes, or 443 grains	35·321 grammes.
Mean of thirty-six days, the quantity of chloride of sodium being 11 grammes, or 169 grains; diet the same	33·895 „
Daily excess with chloride of sodium .	1·426 „
Deduct correction for temperature .	0·575 „
	0·851 grammes,

or 13 grains, as the real increase.

This increase is quite immaterial, and from these experiments it might be concluded that chloride of sodium does not, in any way, influence the urea in men. Boussingault[2] and Bischoff have, however, noticed an increase in dogs, but both sets of experiments have been with reason objected to. Botkin[3] also noticed an increase in urea, and in the water of the urine, during the first six days, when chloride of sodium was given to dogs; later, however, the amount of urea and of the water fell below the normal amount. This looks more like temporary increased elimination than an augmented metamorphosis.

3. The effect on the other urinary ingredients is unknown. In Kaupp's experiments, the total solids of the urine (the urea and chloride of sodium being deducted) were slightly diminished by very large doses, the mean daily lessening being 4·984 grammes, or 67 grains. To what this is attributable future observations must decide, if, indeed, the amount does not fall within the limits of error.

Falck's experiments on himself[4] indicate that the fæces were increased (nearly one fourth), but that the quantity of urine and of insensible perspiration (skin and lungs) was unaltered.

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[1] Handb. der Arzneimittellehre, Band i, p. 131.

[2] Ann. de Chim., tomes xviii et xix.

[3] Virchow's Archiv, Band xv, p. 382.

[4] Handbuch der Arzneimittellehre, Band i, p. 131.

SECTION VIII.

LIQUIDS.

I. Water.

The effect of increased quantities of cold water has been a matter of much dispute. It was believed by Becquerel, Chossat, and Professor Lehmann, that tissue metamorphosis was increased; while Lecanu, Bidder, and Schmidt,[1] have doubted this effect. Bidder and Schmidt, indeed, found that in cats a large addition of water to the circulation absolutely lessened the urea, the sulphuric and the phosphoric acid of the urine. Falck's[2] experiments are also opposed to the first opinion, but they extended over too short a period of time to be satisfactory.

Lately, many and elaborate experiments have been made by Böcker,[3] Becher,[4] Genth,[5] and Mosler,[6] and from an analysis of all these observations the following statements are drawn. They accord with the views of Lehmann, Chossat, and Becquerel.

The drinking of large quantities of water, of medium temperature, may produce different effects, according as the water is taken in a fasting system, and when it is merely added to the ordinary diet.

(*a*) *When large quantities of water* (*of mean temperature*) *are drunk in a fasting system.*

The excess of water speedily passess out, and in great measure by the kidneys; some portion, however, issues by the intestines, as the water of the fæces (though not the solids, Böcker) is usually augmented; and in some cases a small quantity of the water escapes, either by the skin or lungs, or both (insensible perspiration). The greater the quantity of water, the greater is the amount passing off by the bowels and insensible perspiration (Ferber).[1]

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[1] Die Verdauungssaefte und der Stoffwechsel, 1852, p. 343.

[2] Vierordt's Archiv, 1853, p. 151.

[3] Zeitsch. der K. K. Gesellsch. der Aerzte zu Wien, April, 1854, p. 308. See also a very interesting article on this and allied points in the B. and F. Med.-Chir. Review for October, 1854, by Dr. Chambers.

[4] Ludwig's Phys., 1st edition, Band ii.

[5] Untersuchungen ueber den Einfluss des Wassertrinkens auf den Stoffwechsel, von Genth. Wiesbaden, 1856.

[6] Archiv des Vereins fur wiss. Heilk., Band iii, p. 398.

Mosler's elaborate paper has been criticised by Professor Radiche (Wunderlich's Archiv, 1858), but although the experiments are not numerous, they appear to me so uniform that I have adopted the results, without hesitation.

The flow of water from the kidneys causes the urine to become pale, dilute, and of low specific gravity (urina potûs). According to Falck,[2] the increase commences in the first hour, but the maximum of increase is in the second hour after a large, and in the third hour after a smaller, quantity of water; there is also a certain geometrical ratio between the water drunk and that passed by the kidneys. If the water is increased two-fold, that of the urine is increased three-fold. Ferber has also found the increase to occur in the second or third hour, according to the amount of water drunk; in about six hours the additional water has passed off, unless, in consequence of previous loss by sweating, &c., any of it is retained altogether by the body.

2. The urea is augmented (Böcker, Mosler, Becher) at first, but subsequently sinks below its normal amount; so that there is a kind of compensation. The amount of increase varies, but is sometimes very great—as much as 70 to 80 per cent. in twenty-four hours. It has, therefore, been supposed that the water simply acts as a diluent, and, without increasing metamorphosis, carries off a large amount of the urea which always exists in the blood and tissues;[3] but subsequent observations seem to show that it must also augment the exchange of tissue.

3. The condition of the pigment and extractives is uncertain.

4. The uric acid lessens or disappears (Böcker). It must, however, be remembered that in highly dilute urine the uric acid is not readily detected, and it certainly requires additional experiments to prove that there is an absolute lessening of uric acid.

No observations have been made on the hippuric acid.

5. The sulphuric acid is not increased (Böcker).

6. The phosphoric acid is slightly lessened (Böcker).

7. The chlorine is at first augmented; but after the effect of the water is passing off (after the fourth hour), it falls below its normal amount,[4] as if (as may be the case with the urea) it

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[1] Archiv für Heilkunde, 1860, p. 249.

[2] Vierordt's Archiv fur phys. Heilk., 1853, p. 151.

[3] Strahl, Lieberkühn, and Picard (?), have proved the existence of urea in the blood. In some lower animals, it is present in large quantity in the liver and in the muscles; and in man, though not present in muscles, may it not be in the liver and spleen?

[4] Hegar, op. cit., p. 23. Ferber, quoted by Vierordt, Grundriss der Phys., 1860, p. 191; and in Archiv für Heilk., 1860, Band i, p. 248.

had been, as it were, merely mechanically carried out by the excess of water. The time of increase is in the first hour, if the water be in large amount; in the second, if the water is in less quantity. There appears to be a limit to the action of water in this respect; and Ferber noticed that 1200 c.c. (about 2¼ pints) caused as much excretion of chlorine as 1800 c.c.

(*b*) *When (the mode of life being equable) the diet is the usual one, or is regulated for the experiment, and when a large additional quantity of water is taken during the twenty-four hours, the following are the results:*

1. The water of the urine is increased. All the additional water drunk is not, however, excreted by the kidneys; the fæces are usually more watery (Böcker's and most of Mosler's cases). The insensible perspiration (skin and lungs) is also generally augmented, though this is not always the case; and the amount of augmentation varies, apparently, according to individual peculiarity. In some of Mosler's cases it was great; in others trifling. It has been assumed that the formation of water in the body is increased, but the experiments require to be much more precise (Böcker).

2. The urea is increased. All the experiments (Böcker, Mosler, Genth) are in accordance, and I believe (in spite of some strictures by Radiche on Mosler's figures) that this important point may be considered settled. Genth found the mean daily increase, with very great quantities of water, to be no less than 14 grammes, or 216 grains, over the amount passed with the same diet, but without an excess of water. Böcker's results show a much smaller increase (3 grammes, or 46 grains, daily).

Nor is it likely that this increase is to be attributed only to the mere diluent effect of the water, aiding the transudation of urea through the renal glomeruli; for it is not only long continued, but is accompanied by an increase in other ingredients, and (if the diet be the same) by a very rapid loss of weight. It must, then, be attributed to actual increase of disintegration. In Mosler's own case, the loss of weight, and the attendant weakness, were so great as to compel him to discontinue his experiments. His appetite became ravenous, but he would not gratify it, as he was on a regulated diet, *i. e.*, a diet that kept him at a constant weight before the large excess of water was taken. Had Mosler indulged his appetite, possibly the formative processes might have kept pace with the destructive, and his weight and strength would have been sustained. This apparently occurs when the "water-cure" is used in a proper way; while, on the other hand, when the digestive and formative powers of the system are low, the diluent and disintegrating effects of excessive water-drinking are not compensated by an increased supply of nutriment, and injurious results follow.

The effect of water in increasing disintegration varies in different persons; it is greatest in persons of weak habit (in whom it may cause almost a febrile state), and in children, in whom the tissue metamorphoses are normally more active than in adults (Mosler). As a rule, it is greater in women than in men. The effect is also greater when the outer temperature is high; and as a corollary to this, it is greater when the water is warm than when it is cold (Mosler). Bodily exercise increases the disintegrating influence of water, and augments still more the urea.

3. The effect on the "extractives" and pigment has not yet been satisfactorily determined.

4. The uric acid has been found lessened by Genth and Böcker. Mosler did not determine the amount of this substance. This is corroborative of the observations already made on the lessening of the uric acid by water taken during fasting. If the fact be admitted, it is an interesting one. Are the tissues yielding uric acid less metamorphosed, while those yielding urea are more so? or is the urea really increased at the expense of uric acid, as supposed in Liebig's celebrated hypothesis?

Nothing is known of the amount of hippuric acid.

5. The sulphuric acid is augmented (Mosler, Böcker, Genth). The mean amount of increase in Böcker's experiments was 0·34 grammes, or 5·24 grains, daily; in Genth's experiments, it was 0·5 grammes, or nearly 8 grains, daily. It must be assumed that this is owing to increased disintegration and oxidation of the sulphur of certain tissues.

6. The phosphoric acid is augmented, but in a much less degree than in the case of the sulphuric acid.

7. The chlorine is much augmented at first, but the amount falls afterwards; so that, on the whole, the increase is trifling. This was to be expected, as no excess of chloride of sodium is introduced, and as the body retains a certain amount of this substance with great tenacity.

8. As the sulphuric and phosphoric acids are both increased, it must be supposed either that the phosphates are all converted into salts, with one atom of fixed base, or that the absolute amount of the bases is increased. This has not yet been proved by experiment with regard to soda, potash, lime, or magnesia.

Ammonia, however, has been shown, by Neubauer,[1] to be increased by large quantities of water (from 0·8351 grammes in twenty-four hours to 1·926 grammes in one case, and from 0·6361 grammes to 1·5579 grammes in another). Small quantities of water produced no effect.

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[1] Ueber der Ammoniak-gehalt des normalen Menschen Harns., Journ. für prakt. Chem., Band lxiv.

While it may therefore be admitted that drinking large quantities of water not only increases the transudation in the kidneys (by rendering the blood temporarily more dilute, and increasing lateral pressure in the kidney vessels?), but that it augments tissue metamorphosis to such an extent as to cause rapid loss of weight, unless digestion and assimilation be good, and food be freely supplied, it remains quite uncertain on what particular tissues the water acts. From some analyses of blood, by Böcker, it may be concluded that this fluid maintains its integrity pretty steadily, and that the excess of water is speedily got rid of, either by the kidneys or by transudation into organs. If any ingredient suffered it was the blood-cells. It would be a most interesting inquiry to determine what organ becomes richest in water under these circumstances; whether the lungs, the spleen, the liver, or other parts.

It may be suggested that excessive water may not cause actual disintegration of tissue, but may merely cause the albuminous food to pass at once into urea, as some portion is supposed to do in the hypothesis of the "luxus-consumption," by Bidder and Schmidt. Water would then merely check tissue formation, but would not increase tissue disintegration. But the doctrine of the "luxus-consumption" seems now to be so doubtful that this view need not be discussed.

II. Alcohol.

That alcohol (as well as ether) passes off with the breath, when taken in any quantity, is sufficiently perceptible; but it has generally been supposed, since the experiments of Bouchardat and Sandras, that it is not excreted with the urine unless it is taken in very large amount. The statement of Duchek (based, however, on no satisfactory analyses), that alcohol is very rapidly transformed into aldehyde in the blood, and that this substance is then more or less rapidly oxidized into acetic, oxalic, and carbonic acids, &c., also obtained general credence, and seemed to warrant the common opinion that alcohol is a food, belonging to the class of carbo-hydrates, and that its combustion gives out an equivalent proportion of heat. Arguments for the use of alcohol, in health and disease, have been based on this belief; and the late Dr. Todd, in particular, strongly urged the claims of alcohol to the rank, not only of a stimulant, but of a valuable food.

Yet it is at present by no means certain that alcohol is so easily destroyed in the system. The observations of Masing, Strauch, and Buchheim[1], have refuted Duchek's statements of the metamorphosis of alcohol; and the late observations of Perrin, Duroy, and M. Lallemand,[2] show that alcohol can be much more easily discovered in the urine than has been supposed; these observers, indeed, deny that alcohol is oxidized in the body, even in the slightest degree; and though this opinion may be considered to go a little before the facts, there is no doubt that they have shown that much of the alcohol is not destroyed, and that possibly none of it is so. It passes off very slowly, both by the kidneys and lungs, and in the body appears to tarry in largest amount in the liver and in the brain.

(*a*) *When added to a regulated diet.*

1. It lessens the water of the urine (Böcker[3] and Hammond[4]).
2. It lessens the urea (Böcker and Hammond).

The amount to which it did this in Böcker's experiments (7 to 12 drachms of alcohol in twenty-four hours) was enormous; the daily decrease being no less than 13·366 grammes, or 206·2 grains. Hammond made the decrease only 87 grains, with the usual diet. As there appeared to be no subsequent discharge of urea, and therefore no retention, and as the amount of food remained the same, it must be considered that alcohol retards the formation of urea. This conclusion is rendered still more probable, from the effect produced on the other urinary ingredients, and from the well-known fact that alcohol also lessens the amount of expired carbonic acid, although it does not lessen the pulmonary aqueous vapour (Böcker).

3. The effect on the creatin and creatinin is not known; but the "extractives" generally, and among them the pigment, are much lessened (Böcker). The blood-cells are therefore less rapidly broken down. Is this from the effect of alcohol on the liver?

4. The uric acid is slightly lessened (Böcker and Hammond); but there are exceptions to this, and, on the whole, the effect of alcohol on this substance seems to be inconsiderable. The effect on the hippuric acid is unknown.

5. The sulphuric acid is lessened, in Hammond's case, by no less than 13 grains daily; a remarkable diminution, as the urea was, in Hammond's case, not proportionately affected.

6. The phosphoric acid is lessened (Böcker). The exact daily

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[1] Lehrb. der Arzneimittellehre, 1859, p. 420.
[2] Comptes Rendus, Oct., 1859; and L'Union Méd., 1859, No. 127.
[3] Beitrage zur Heilkunde, vol. i, p. 240.
[4] American Journal of Medical Science, October, 1856.

lessening of the earthy phosphates, in Böcker's experiments, was 0·278 grammes, or 4 grains.

7. The chlorine is greatly lessened; and this must evidently be from retention, as there is no want of ingress, and no increased egress by the skin or bowels; during the use of alcohol, the skin acts no more, and the bowels slightly less, than usual.

8. The bases must be, of course, also retained.

9. The free acidity is lessened (Hammond). This might have been anticipated, from the lowering of the amount of sulphuric and phosphoric acids.

Alcohol, in Böcker's experiments, had no effect on the bowels or on the skin.

(*b*) *Alcohol in a starving and over-fed system.*

Hammond is the only person who has yet made experiments on these points, and his results require confirmation: the same effects appear to follow, whether the diet be as usual, or be insufficient, or in excess. In both the last cases, however, Hammond noticed a very slight and immaterial increase in the uric acid.

The effect of alcohol is, then, it appears, to cause retention of the chloride of sodium, and perhaps of other salts, and to lessen the formation of urea, of the extractives, and of sulphuric and phosphoric acids. Altogether, the asserted diminution of excretion is enough to create some surprise. In Böcker's own case it was nearly one half, *i. e.*, as if he had suddenly become reduced in weight by half his bulk. It is impossible to suppose that this holds good for all persons; indeed, Hammond's observations are much more moderate; but it is evident that the effect of alcohol on the tissue change in temperate persons must be very great, if these experiments are correct. Perhaps, use may lessen this effect; but at present no observations have been made on habitual alcohol-drinkers which can solve this interesting question.[1]

III. SPIRITS.

As brandy, whisky, gin, and other spirits, contain, besides alcohol, some quantity of ether and essential oils, it cannot be concluded, *à priori*, that their effects on the urine will be similar to those of pure alcohol. At present no observations of value have been made on this point. Gin is popularly regarded as a diuretic, (*i. e.*, as an eliminator of water), but sufficient attention has not been paid to the quantity of water taken with the spirit.

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[1] A number of observations on the urine of intemperate persons, whose age, weight, and amount of food is known, would be most important.

The ether of some spirits is easily detected in the breath. Edward Smith found a difference in the effect of brandy and gin, on the one hand, and rum on the other, on the pulmonary carbonic acid: the latter increased it; the two former lessened it.

IV. Wines.

The composition of wines is so varied, the salts, volatile oils, and ethers differing in quantity, and frequently in quality, in almost every case, that even without reference to their per-centage of alcohol, the effect of wines on the metamorphosis of tissue must be a most complicated study. At present little has been done. Böcker[1] has examined the effect of a white (Niersteiner) and a red (Walportzheimer) Rhine wine, and has shown that they produce effects quite different from those of pure alcohol (owing to their salts?). The white wine increased to a slight extent all the constituents of the urine, while the red wine left the urea unaffected, and augmented only the water and fireproof salts. The pulmonary CO_2 was lessened by both. The intestinal and cutaneous excretions were unchanged.

Liebig has stated that wine increases the uric acid.[2] Champagne and other carbonated wines largely increase the carbonic acid in the urine, and they are said also to augment the oxalic acid.

V. Beer.

(*a*) When a large quantity of beer is drunk at one time, it causes (like water) a vast amount of urine of low specific gravity to be passed; as far as at present known, however, there is no simultaneous increase of the urea or other solids,[3] or, if anything, the solids are diminished.

(*b*) When beer is taken in lesser quantities, as a daily article of food, instead of water (in quantities of two to six pints), the diet being the same as usual, its effects must necessarily be different, according to its composition, and especially according to the amount of spirit and of salts it contains. An elaborate series of investigations, by Böcker,[4] with beer, containing from 4·7 to 5·4 per cent. of alcohol, show that there was a very considerable diminution in the amount of urea, while the uric acid was slightly augmented during its use. The extractives, the sulphuric acid, and the phosphate of lime, were also slightly lessened, while the fireproof salts, and especially the chloride of sodium, were increased. This last result is the more remarkable, as the beer contained only traces of chloride.

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[1] Beitrage zur Heilkunde, vol. i, p. 297.

[2] Moleschott, Handbuch der Diatetik, 1850, p. 546. For a good account of the experiments on wine, I beg to refer to Dr. King Chambers's article in the B. and F. Med.-Chir. Review, 1854.

[3] Vogel, Archiv des Vereins, Band i, p. 108. Winter, op. cit. Rudolph, op. cit.

[4] Ueber die Wirkung des Biers auf den Menschen (Archiv des Vereins für wiss. Heilk., Band i, p. 343).

The carbonic acid of the lungs was diminished by the beer; the solids of the fæces were slightly increased (from 642 to 720 grains in twenty-four hours).

When beer was taken during inanition, by Dr. Böcker, the same effect of diminished excretion was also marked. The loss of body-weight which occurred during a fasting period of twenty-four hours, when water was taken, was greater than during an equal period when beer was substituted for water. The solids of the urine were increased, during the twenty-four hours when beer was taken, by 4 grammes, or 62 grains, chiefly by an increase in the chlorine and phosphoric acid; but as the solids of the beer amounted to 188 grammes, it follows that 184 grammes, or 2,840 grains, were retained in the body.

The effect of beer is, therefore, similar to that of alcohol, though in a much less degree; and the influence on the urine of the small quantities usually taken in this country by persons of the better classes must be inconsiderable.

VI. Tea.

(*a*) When a large quantity of infusion of tea is drunk at once, the water of the urine is of course largely increased; the solids are not increased, as far as known, but remain unaltered.[1]

(*b*) When the diet remains as usual, but, instead of all other liquid, infusion of tea is taken, the effects, according to Böcker[2] and Hammond,[3] are—

1. To leave the water unaffected.
2. To lessen the urea; inconsiderably in Böcker's experiments (14 grains in each twenty-four hours—a quite immaterial amount); slightly more in Hammond's (52·95 grains). Professor Lehmann, indeed, has stated that the urea has increased[4] by immediate formation in the blood (from thèein?); but this appears to be erroneous.
3. The uric acid is lessened (2 grains, Böcker). In Hammond's experiments the diminution was considerable. It is to be presumed that this is from lessened formation, and not merely from retention.

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[1] Rudolph, op. cit.

[2] Ueber die Wirkung des Thees auf den Menschen. Archiv des Vereins, Band i, p. 173.

[3] American Journ. of Med. Sci., April, 1856.

[4] Phys. Chem., 2d edition, Band i, p. 173.

4. The sulphuric acid is slightly lessened; the phosphoric (in Hammond's experiments), more largely (18·26 grains daily).

5. The chlorine is lessened (46 grains, Böcker; 16 grains, Hammond); but not in any noticeable degree.

Altogether the effect of tea on the urine is slight, and, indeed, quite unimportant. In Böcker's own person, tea had more effect on the intestinal discharges, which it lessened one half (from the small portion of dissolved tannin?). It produced no effect on the insensible perspiration, or on the carbonic acid of the lungs.[1] In E. Smith's experiments, however, it appeared to increase the pulmonary CO_2, and is considered to be a "pulmonary excitant;" so that this point must be considered as undecided.

(*c*) When the diet is insufficient, the body, in Böcker's experiments, loses weight less rapidly with tea than without it.[2]

VII. Coffee.

This subject has been investigated by Böcker,[3] L. Lehmann,[4] and Hammond.[5] The results are, in all three cases, very similar. As the efficient principles of coffee are caffein and a very large proportion of empyreumatic oil, its effects are, of course, compounded of the joint action of these two substances. When, on usual or regulated diet, infusion of coffee is taken instead of other drinks, the results are—

1. The water of the urine is increased (Böcker, L. Lehmann), or only very slightly lessened (Hammond).

2. The urea is greatly lessened (all three observers).

Hoppe[6] also, by experiments on dogs, has confirmed this statement.

3. It was observed by Scherer, in commenting on Böcker's experiments, that possibly the diminution of the urea might be attended with increase in other constituents, such as creatinin; but, at present, this suggestion has not been worked out, and the effect on the creatine and extractives generally is uncertain. But Böcker found the "volatile salts and extractives" greatly les-

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[1] In some popular works, the effect of tea or of theine in lessening excretion is stated to be very great, so that it becomes unnecessary to take much food. But these statements are based on no accurate experiments; at least, I know of none.

[2] In the prison at Wakefield, it has been supposed that tea causes a loss of weight; but it seems to me very desirable that these experiments should be repeated. Böcker's experiments are quite opposed to them.

[3] Beitrage zur Heilk., Band i, p. 188.

[4] Liebig's Annalen, Band lxxxvii, p. 205.

[5] Amer. Journ. of Med. Sci., 1856.

[6] Meissner's Report on Phys. for 1857. Henle's Zeitsch., 1858, p. 355.

sened, which does not look like an increase of creatine or creatinin.

4. The uric acid was found to be decreased slightly by Böcker; largely, by Hammond.

5. The sulphuric acid was found to be immaterially lessened by Hammond.

6. The phosphoric acid was largely decreased in Böcker's and Lehmann's experiments. In Hammond's it was normal. Further experiments on this point (a very interesting one in connection with the metamorphoses of the nervous system) are much needed.

7. The chlorine was found to be much lessened by all three observers.

8. The condition of the bases (potash, soda, lime, magnesia, and ammonia) is not known.

These results are attributable, by L. Lehmann, chiefly to the essential oil. Caffein produces the same effects, but in a much less degree. The nervous symptoms (tremors, increased cardiac action, &c.) are usually ascribed to the caffein. The pulmonary carbonic acid is, according to Edward Smith, increased by coffee as by tea. In dogs, Hoppe has also noticed an increase; so that in this case the alterations in the urea and pulmonary CO_2 do not run parallel.

VIII. Cocoa and Chocolate.

It is supposed that these substances have the same effect as coffee, but exact experiments on the urine have not yet been made.[1]

IX. Peruvian Coca (Erythroxylon Coca).

The remarkable dietetic effects of the Erythroxylon coca[2] have led to the belief that it must limit the metamorphosis of tissue. Its power on the nervous system is evidently analogous to that of hemp and opium, and it also, after a time, weakens the digestive organs, and deranges greatly the action of the liver. The condition of the urine has not been properly examined, and it cannot be said whether or not there is any alteration in it.

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[1] The little work of A. Mitscherlich (Der Cacoa und die Chocolat, 1859), the last on the subject I can find, contains nothing bearing on this point.

[2] A very full and interesting account of Poeppig's statements on this subject, which all succeeding writers have quoted, will be found in Sir William Hooker's Companion to the Botanical Magazine, 1835, p. 161, for a reference to which I am indebted to Dr. Joseph Hooker. Reference can be made also to Johnston's Chemistry of Common Life.

The latest writer on the subject, Mantegazza,[1] states that the urine is increased; but no analyses are given, and the assertion is not more worthy of credit than those which have been made in a contrary sense.

The various liquids ordinarily taken as food[2] are thus divisible into two great classes, those which favour, and those which more or less retard, urinary excretion. To the first class belong water and the lighter wines; to the second, alcohol, strong wines (probably), strong beer, tea, and coffee. The retardation of excretion produced by the second class is, however, not shown merely by the urine, but in several cases also by the pulmonary, the cutaneous, or the intestinal excretions. It can, therefore, scarcely be doubted that the action of these substances is not merely that of retaining certain excretions in the body, but that of absolutely lessening their formation. They appear, in fact, to retard metamorphosis, though in different degrees and in different directions; some acting remarkably on the urine, but less on the intestines, as coffee; others influencing the urine very little, but the bowels more, as tea. These substances differ also in their mode of action, even on the urine: thus tea appears to slightly lessen the uric and the phosphoric acids, while it scarcely affects the urea; while coffee not only affects the chloride of sodium, but lowers remarkably the urea, the uric acid, and (probably) the phosphoric acid. No doubt also other differences will be made out, and each substance will be found to have its specific action.

Although the effect on the urine of these substances is thus tolerably well known in systems which are carefully arranged for the experiment, it remains to be seen how far in actual life their effects are counteracted by custom, habits, or peculiarities of race and climate. It is impossible to suppose that every drinker of spirits has always such a small excretion as occurs in the temperate man, who suddenly (for the sake of the experiment) introduces a large quantity of alcohol into his body. The effect of the alcohol may be counteracted by other conditions, such as the use also of large quantities of water, of great exercise, or like agencies, which augment metamorphosis.

The exact steps of the process by which this retardation of metamorphosis is brought about are not yet known; we see only the results. Is it from simple appropriation of oxygen, or from some more complex action of nutrition directly, or through the medium of the nerves? Is the process of the building of the tissues equally delayed with that of their unbuilding? In many cases, the use of these agents in large quantities lessens the desire for food, and the body maintains its weight on less nutriment than would have been the case with water or light wines.

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[1] Schmidt's Jahrb., 1859, No. 12, p. 349.

[2] I have not alluded to milk or whey, as I am unacquainted with any trustworthy experiments on the urine.

How far this result is a good one—how far the normal rapidity of metamorphosis (such as occurs with moderate water-drinking) can be advantageously checked by the use of such substances—is a social problem of the highest importance. It seems to me, that the obvious deduction from our present physiological knowledge is, that the more rapid the healthy metamorphosis of the body, within certain limits, the more urea and pigment are formed, the more perfect is nutrition, *as long as nutriment is supplied in sufficient amount*, and as long as the formative powers can use it. In the immense excretion of children, and in the retarded metamorphosis of old age, we see the two ends of the scale, and have the proof that growth and progress are corollaries of rapid metamorphosis and elimination. Have we then a right to conclude, that anything which impedes healthy metamorphosis is hurtful, and that, in checking disintegration, it will equally check formation? Perhaps, without going at present quite to this length, we may believe that the most perfect condition of health is rapid building and rapid unbuilding; and all the most strengthening hygienic means, as exercise, sea air, saline baths, and abundant nutritious animal food, act by forwarding both these processes. Appetite increases, but at the same time the action of the eliminating organs is also increased; the body gains weight, although there must be increased rapidity of the molecular currents and of chemical changes.

The training for the ring may be taken as an illustration of my meaning. The prize-fighter eats largely of animal food; he thus, if Bischoff's and Voit's experiments be received, increases both the formation and the disintegration of tissue; and it is to be presumed, that the excretion of urea during training must be increased. The prize-fighter brings into play another factor of elimination, for he gradually increases his muscular movements to an enormous extent; and, by so doing, he must absorb much more oxygen than usual, and give out more carbonic acid. (Seguin, Hoffman, Vierordt, E. Smith.)

All the three great factors of metamorphosis, viz., nitrogenous food, oxygen, and movements, are thus increased; and the amount of metamorphosis must also go on augmenting, up to a certain point, as the bulk of the tissues increases.

So far the prize-fighter may be said to follow the dictates of common sense; but now how does he act with regard to alcohol, and wine, and the substances usually supposed to give strength, and to limit the necessity for food? Why he almost discards their use; he takes no spirits, no wine, only a little weak beer (which he might with advantage leave off); but drinks to any amount of pure water, or fluids equivalent to it; and thus taught by experience, he employs another most potent agent in elimination.

Under this regime, his health improves wonderfully; he can bear any fatigue, morbific causes are comparatively inoperative, injuries are more easily recovered from, and, for the time, he is the very type of health and vigour. That the class is not a healthy one, is owing to the reckless living between the periods of training.[1]

If, then, nitrogenous food is abundant, the use of substances to check metamorphosis, within physiological limits, seems unphilosophical. If the food be insufficient, then the use of these substances may become desirable. Yet, as Liebig says, the use of alcohol, coffee, tea, and such substances, is so universal as to look like an instinct; and some decided benefit must be at the bottom of a custom so general. The explanation usually given, that these substances are taken, because, by lessening metamorphosis, they lessen the desire for food, and maintain the body at the same weight with less nutriment, may account for some but not for all cases; and it is most probable that their immediate sensible effect on the nervous system is that which is wished for by those who take them, and that, as already said, any part of their action which might be injurious is commonly counteracted by other habits which are almost as instinctively adopted as is the use of these substances themselves.[2] Yet I must candidly say, with regard to the stronger alcoholic liquids, that what study I have been able to give to this subject, and to the causation and treatment of disease generally, have led me more and more to adopt the view of Carpenter and others, and to believe that the use of alcohol in health is not only unnecessary, but is absolutely injurious. The effect of light wine, beer, tea, and coffee, in impeding metamorphosis, is, however, so inconsiderable, and their irritating effects on tissues are so slight, that there seems nothing to urge against their moderate use.

Whatever may be the difficulties, at present, of discussing this most important dietetic subject in the case of healthy persons, there can be no doubt that what is known of the action of these substances assists us very much in using them in disease. The nervous system is stimulated, and metamorphosis lessened, by coffee, and slightly by tea; and in exhausting diseases these effects are most useful.

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[1] These remarks were written long before the late prize-fight so strongly directed the public attention to the effects of training. In the Lancet, and other journals, most sensible remarks have been made on this point; and if the attention of the profession is directed to the true sources of strength of body (which will not be found in the use of alcohol), this celebrated contest will have done much good.

[2] I may refer to an interesting article on tea, coffee, &c., by Dr. King Chambers, in the B. and F. Med.-Chir. Rev., 1854.

I presume that, while sugar, starch, &c., are available, it can seldom be necessary to employ alcohol as a factor of heat; this object can be obtained by more easy and more certain methods. The physician, as I take it, uses alcohol for two great purposes—as a direct stimulus to the weakened stomach, and as a stimulant of the nervous system, and, through it, of the failing heart.[1] Now, in our choice of alcoholic fluids, we must be guided, it appears to me, by the consideration of how far it is wished, at the same time, to check or to increase elimination. For example, in the last stages of fever, when the body has wasted almost to extremity, and when, as the controlling power of the nervous system is lost, too great disintegration may still go on, even in the emaciated tissues, pure alcohol, which stimulates the heart's action, and yet impedes metamorphosis, must be employed; while, in other cases, in which, while the nervous system and the heart must be stimulated, it is desired not to check excretion (as during the absorption of exudations), the lighter wines, or the combination of spirit with alkaline salts, should be chosen. In the vast class of chronic complaints dependent on lesions of nutrition, obstinate congestions, and continued parenchymatous inflammation, and in which, as a rule, digestion is weak and tissue change is lessened, the same rules hold good; and, by a judicious combination of means, we may obtain from these substances the effects we desire from them, and can counteract and nullify the influences which should be avoided.

SECTION IX.

FASTING.

Fasting may consist in abstinence from solids or liquids generally, or from one or more special ingredients of the diet. The influence of food usually ceases in about twelve hours (Falck), and after that time the urine represents only tissue metamorphosis (urina sanguinis, or urine of inanition). Occasionally the influence of food lasts for sixteen or twenty hours

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[1] This opinion is not that of the late Dr. Todd, who emphatically recommended alcohol as a food. But its local irritating effects on the liver and nervous tissues seem to me to render it as undesirable a food as can well be named, unless those irritating properties are expressly desired; while the evidence of its destruction in the system is, as already said, very incomplete. We know only that, if destroyed, it is so only partially, and with difficulty. Its rank as a heat-giving food cannot be high, if indeed it be a food at all.

(Voit); and I am informed by Dr. Edward Smith, that he has found the effect of a large meal extend beyond this time, even for two or three days.

1. *Fasting from solid food; the usual amount of liquid being taken.*

This may be incomplete or complete.

(A) When a healthy man, who has been taking good diet, is placed on meagre food, such as the low and fever diets of our hospitals, there is usually a great diminution in the chief urinary solids.

1. The urea is, as a rule, at once reduced. In some experiments by Moos,[1] it fell from 28 to 14 grammes per diem (from 432 to 216 grains); in an observation of Schneller,[2] it fell from 30 to 14 grammes. Brattler[3] noticed a fall from 33·8 to 24 grammes, in a man of twenty, when his diet was reduced (mean of four days).

Exceptions to this rule are said to occur. Beigel[4] kept six men on very meagre diet for some days: the urea at first did not diminish; eventually, however, it fell rapidly. In some of V. Franque's observations, also, the fall in the urea did not occur so rapidly as in Moos' and Schneller's cases. Possibly, individual peculiarity in the rapidity of tissue change will account for this difference of time. If the fasting be continued, the urea continues to fall in proportion to the time and to the lessening weight of the body.

2. The uric acid has not been properly examined during long fasting: short fasting lessens it[5] very considerably; whether it continues to fall, is yet unknown.

3. The sulphuric acid is lessened, but not in so great a degree as the urea; the amount is about one fifth in the experiments hitherto made.[6] In some of Gruner's experiments the amount did not fall; but then beer and coffee were taken, and may have influenced the result.

4. The phosphoric acid is much lessened (one half or one third), and the phosphates of lime and magnesia almost disappear.

5. The chlorine lessens rather rapidly; and on a rather meagre diet, such as the half and low diets of our hospitals, I have found the excretion of chloride of sodium to be only 1·5 to 3·5 grammes

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[1] Ueber der Harnstoff und Kochsalz-Gehalt. Henle's Zeitsch., Band vii, p. 291.

[2] Schmidt's Jahrb., 1856, No. 10, p. 10.

[3] Ein Beiträg zur Urologie. Munchen, 1858, p. 6.

[4] Op. cit., p. 34.

[5] Ranke, Ausscheidung der Harnsaure, p. 13. Twenty-four hours fasting lowered it from 0·648 grammes to 0·339 and 0·394 grammes.

[6] It is probably about one third, or more, as at least this amount is derived directly from the sulphates of the food.

per diem, instead of 5 to 9 grammes. Brättler found the chloride of sodium to fall from 13 to 7 grammes, when the diet was very meagre.

6. The extractives lessen, but less in proportion than the urea.[1]

(B) In total fasting, as in voluntary starvation or in experiments on animals, all the urinary ingredients diminish very rapidly for two or three days, in a regular ratio, proportioned to the length of starvation and the decrease of body-weight.[2] If, as in voluntary starvation, water be also abstained from, the water lessens proportionably more than the solids; the chlorides lessen more than the other solids, and at length entirely disappear (Schmidt, in cats); the urea lessens proportionably more than the extractives, or than the sulphuric and phosphoric acids. So that as the water lessens more than the pigment, the urine becomes darker, and the relative preponderance of the sulphuric and phosphoric acids augments the relative acidity of the urine. Both these facts are of importance in practical medicine, as the urine of disease is often an urine of inanition, and the characters really owing to deprivation of food might be ascribed to disease.

Whatever, however, be the period of starvation, some portion of urea and of the extractives are still formed (at the expense of the tissues of the body) and excreted (Berzelius, Lassaigne, Scherer, Becher). Bernard[3] states that uric acid, hippuric acid, extractives, &c., disappear in starving animals, and that the urine is merely a concentrated acid solution of urea; but these results are not accordant with those of other observers, who have found uric acid and extractives in the urine of the most prolonged inanition.

2. *Fasting from Liquids.*

Abstinence from liquid has often been a favorite mode of treatment, but the effects on metamorphosis of tissue are very little understood. Falck and Scheffer,[4] in animals to whom solid food only was given, found the quantity of urine was greatly lessened; some, however, was always passed, and it contained all the usual ingredients, though in what proportion was not determined.

Mosler[5] has lately very carefully investigated this point in children, young women, and young men. In every case the excretion of urine, both as to water and solids, was very much lessened. To cite one case as an example (No. 7, p. 437), it was found that with the same solid food and mode of life, but with a very diminished quantity of water, a man excreted in twenty-four hours—

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[1] Lehmann, Handbuch der phys. Chem., 1859, p. 285.

[2] In starving dogs, Bischoff and Voit (Ernährung des Fleischfressers, p. 271) noticed that much bile pigment passed into the urine. The bile acids could not be found. So also Bernard (Leçons, Band ii, p. 69) found clear indications of bile pigment in the urine of starving animals.

[3] Leçons, Band ii, 1859.

[4] Valentin's Report in Canstatt's Jahresb. for 1853. p. 187.

[5] Archiv des Vereins für wiss. Heilk., Band iii, p. 398.

Less urinary water	by	. . .		1300 c.c.
„ urea	„	8·64 grammes,	or	133·4 grains
„ ClNa	„	10·01 „	„	154 „
„ PO_5	„	2·88 „	„	44 „
„ SO_3	„	1·56 „	„	24 „

When fluid was again given, the urinary water still remained for some time below its normal amount, as if the thirsty body eagerly appropriated, and obstinately retained, some of the new supply; subsequently there was a great increase in the urea and the ClNa, either from the pouring out of these substances after retention, or from increased metamorphosis succeeding a period of inaction. Probably there was, at any rate, retention and subsequent elimination.

But that the deprivation of water does really cause, not only retention, but absolute diminution of urea formation (*i. e.* of tissue change) seems likely, because the insensible excreta, and especially the pulmonary carbonic acid, are lessened also (Mosler, p. 445). The stools also are lessened in amount.

These effects, in Mosler's experiments, were most marked in children, in feeble persons, or in those whose previous occupation had tended to produce a rapid metamorphosis.

3. *Fasting from Chloride of Sodium.*

Wundt[1] has tried the effect of total abstinence from chloride of sodium. When perfectly salt-free food was taken, the following was the result:

IN TWENTY-FOUR HOURS.

Day.	Quantity of chloride of sodium in urine with salt-free food.	Quantity of urine.
	Grammes.	C.C.
1	7·207	2022
2	3·623	1428
3	2·437	1216
4	1·359	1341
5	1·091	1045

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[1] Erdmann's Journal für prak. Chem., 1853, No. 13, quoted in Canstatt. I have not seen the original paper.

On the third day, *the urine became albuminous.* The lessening in the water of the urine was very marked, and leads to the notion that chloride of sodium may play an important part in diffusion of fluids. The production of albuminuria is a most important observation, and it is very desirable the experiment should be repeated. It seems to support the idea that the freedom of the healthy urine from albumen is owing to the albumen, during its transit through the renal tissues and epithelium, being rendered insoluble by the action of acids in the presence of chloride of sodium.

SECTION X.

EXERCISE.

The effect of exercise has been examined by Professor Lehmann,[1] Simon,[2] Percy,[2] Beigel,[3] V. Franque,[4] Hammond,[5] Beneke,[6] John C. Draper,[7] J. Lehmann[8] and Speck,[9] as well as partially by Mosler, Gruner, Ranke, Bence Jones, and others.

The general result of all these experiments comes out pretty clearly, though there are some exceptions and several discrepancies of statement. Strong exercise increases the waste of the body, so that it loses weight even under a diet which had previously, not only kept it at the same, but had even caused it to gain, weight (Speck). This loss of weight appears to be caused by increased elimination both of fluid and solid matters, which takes place by the skin and lungs principally, and by the kidneys in a less degree. The intestines do not ordinarily share in the increased excretion (J. Lehmann, Speck).

The increased excretion of solids referred to, affects both the nitrogenous substances and the carbo-hydrates. The elimination of carbon, indeed, has long been shown, by the experiments of Hoffmann, Vierordt, E. Smith, and others, to be greatly augmented; and Speck's observation show that this elimination takes place in a much greater ratio than that of nitrogen. Some time after the period of increased exertion is over, the excretions lessen below the point proper to the period of rest, as if the metamorphic changes were lessened as compensation for the previous waste. This increased elimination is attended with no long-continued rise of temperature (Speck), or a very slight one (J. Lehmann); although, during the period of great exertion there is, for the time, a considerable rise; but the respirations are augmented in number, and the heart's action is quickened during the time, though subsequently the rapidity of the heart's action falls below the normal amount.

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[1] Phys. Chem., 2d edit., Band ii, p. 449.

[2] Chemistry of Man. The per-centage determinations only are given. This is the case also with Percy's experiments, recorded in the same work.

[3] Op. cit., p. 42.

[4] Schmidt's Jahrb., 1856, No. 10

[5] American Journal, 1855.

[6] Nord-See Bad., 1855, p. 83.

[7] New York Journal of Med., 1856, p. 155.

[8] Archiv für wiss. Heilk., 1860, Band iv, p. 484.

[9] Ibid., p. 521.

When the channels of elimination, the skin and lungs on the one hand, and the kidneys on the other, are more closely examined, it is found that, as in so many cases, there is a sort of inverse ratio between them. In some cases the insensible perspiration is augmented in an enormous degree, and then the increased urinary elimination is less, or sometimes, indeed, not at all marked; while, if the insensible perspiration is not augmented, the urinary excretion is greatly so. This alternation of action, probably, explains many of the apparently different experiments.

The changes in the several urinary constituents are as follows:

1. The water of the urine (if no fluid be taken) is generally lessened, and the colour of the urine, therefore, becomes deeper. This diminution is noted by most observers. Hammond, however, in some of his experiments, found the water increased; and in two out of five of J. Lehmann's series of experiments, it was unaltered. There can be little doubt that this depends on the amount passing off by the skin and lungs: when exercise does not produce sweating, the urinary water is not lessened. In Gross' experiments,[1] the urine decreased *in proportion* to the increased perspiration.

2. The urea of twenty-four hours has been found to be increased, by Professors Lehmann, Beigel, V. Franque, Hammond, Beneke, and Speck. The amount of increase varies, but is often considerable (ten to twenty-five per cent.). Occasionally it is not increased; this was the case in two of Julius Lehmann's series, but then, in both these cases, there was great sweating; while, in two cases in which there was no sweating, the urea was increased. In Speck's case, also, when the sweating was profuse, the urea was not increased. The explanation naturally arises, that as urea will pass off by the skin, as indeed it has been found by Funke and G. H. Meissner, to be greatly augmented in the sweat of exercise, so in these cases, without in-

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[1] Beitrage zur Kenntniss der Mensch. Stoffwechsels. Inaug. Diss. Giessen, 1855

crease of urea in the urine, there may have been a great passage by the skin.

Dr. John C. Draper believes, from his experiments, that the urinary urea is not increased, and suggests that the nitrogen set free by the increased muscular action may pass off by other channels. This is likely enough; but I must also say, that an analysis of Draper's experiment has convinced me, that they are not of weight, and ought to be put aside.[1]

Whether or not some nitrogen does really pass off in larger quantity by some other usual channel (other than urea, as by the lungs as ammonia), or by some altogether fresh channel, is quite uncertain.

The increase in the urea occurs during the period of exercise, and for some time afterwards (four to eight hours?); the amount of urea then falls even below the mean, so that a partial balance is established, and the increase of twenty-four hours is not so great as would have been anticipated from the large amount formed during and just after the exertion.

If, when great exercise is taken, the diet is very meagre, the increase of urea, though still perceptible, is less marked; the body rapidly loses weight, but this is less from elimination of nitrogen than from an immense excretion of carbon from the lungs (Speck). In other words, if the supply of nitrogen be deficient, and yet exercise be persevered in, the waste is chiefly in the carbo-hydrates; the body seems to hold back, as it were, with great tenacity, some of the nitrogen.[1]

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[1] As Draper's experiments are contrary to so many others, I give them in more detail. The urea was determined by decomposing it by nitroso-nitric acid, and absorbing the CO_2 by barytic water.

1. In the first series of experiments, eighteen days' observations are given; but it would appear that they are not all on one individual, and there is therefore a fallacy. Each person walked three miles a day.

The mean amount of water in 24 hours was 1106 c.c.
„ urea „ 27·213 grammes.
The relation of the urea to the solid residue was as 490 to 1000.

2. In the second series, the urine of a man in absolute rest (broken leg) was determined.

Mean amount of water (3 days) . . . . 796 c.c.
„ urea „ . . . . 26·47 grammes.
The relation of the urea to solid residue was as 502 to 1000.

Draper therefore considers that rest does not decrease the urea; but it is at once evident that he has no right to compare this man's excretion with the mean excretion in the first series, which is given by two other persons. We do not know what the excretion may have been in this man when in exercise.

3. One of the individuals of the first series walked thirteen miles a day, at the rate of 4½ miles an hour.

Mean amount of water (2 days) . . . . 905 c.c.
„ urea „ . . . . 25·472 grammes.
The relation of the urea to the solid residue was as 489 to 1000.

Therefore, Dr. Draper says exercise lessens the urea. But it is quite clear that the amount of exercise is not properly described by the terms "walked three miles or thirteen miles a day." Much exercise may be taken by a man who walks little. Again, twenty-four hours is perhaps too long a term for the examination. An increased excretion following quick walking is sometimes compensated by a subsequent lessened flow; and again we really don't know what was the normal excretion of this individual.

But the principal objection is, that the mean of two days is by no means sufficient, and it is not stated how soon the days of exercise followed the days of tranquil walking. The conditions of the experiment, in fact, are not precise.

3. Creatin, creatinin, and extractives.—Beyond a statement of Professor Lehmann's,[2] that the extractives are lessened by exercise, nothing is known on this head.

4. The uric acid is said to be lessened, by Prof. Lehmann.[3] Hammond also noticed a considerable lessening, after strong exercise.

Beneke found strong exercise for three hours increase it.[4] So also Genth[5] and Heller.[6]

Ranke,[7] in two persons, found little effect, or indeed a slight lessening, to be produced by moderate exercise; but very powerful and unaccustomed exercise increased it by nearly one third.

J. Lehmann found it not to be lessened, but not decidedly increased. Speck, on the other hand, found it most decidedly and considerably increased (50 per cent.).

The evidence is therefore very discrepant, but is strongest in favour of the increase.

5. Hippuric acid.—The experiments on this head are extremely imperfect; in fact, are not to be relied on. It has been affirmed that intense exercise causes its total disappearance (Bird).

It was stated by Roussin[8] (in opposition to Marchand) that in hard-worked horses the hippuric acid is very large, while unemployed, well-fed horses excreted but little hippuric acid. The condition of the urea was stated by this observer to be exactly the reverse. Hallwachs and Weissmann,[9] however, found hippuric acid in all cases, but it was certainly larger in the labouring horses.[10] Hallwachs did not determine the amount of urea; and Roussin's experiments on this point are not satisfactory, as he does not appear to have obtained the exact amount of urine.

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[1] This is a curious result from Speck's elaborate experiments. It will be very desirable to test it by future observations.

[2] Phys. Chem., 2d edit., Band ii, p. 449.

[3] Ibid.

[4] Nord-See Bad., 1855, p. 83.

[5] Einfluss des Wassertrinkens auf der Stoffwechsel.

[6] Quoted by Ranke. But as most of Heller's analyses are per-centage amounts, I don't think much weight attaches to the observation.

[7] Ausscheidung der Harnsaure, p. 14.

[8] Gazette Médicale de Paris, 1856, No. 15; and Meissner's Report on Phys., Henle's Zeit., 1856, p. 296.

[9] Op. cit., and Meissner's Report for 1857. Henle's Zeitsch., p. 320.

[10] Marchand stated that the urine of plough-horses contained benzoic, but no hippuric acid. This is no doubt wrong, but Hallwachs has shown that there

6. Sulphuric acid.—Exercise increases this acid, according to Bence Jones and Beneke. Vogel, from an examination of Gruner's and Clare's experiments, states that they lead to no certain result.[1] Gruner, however, explicitly states[2] that *very* great bodily exercise did increase the sulphuric acid; and this statement is entirely confirmed by J. Lehmann and Speck, who both found a considerable augmentation. The increase may be considered to be, in fact, quite proved.

7. The phosphoric acid was found by Mosler,[3] Hammond,[4] and Speck to be increased. This is not constant, however, as Beneke, from three hours' strong exercise, observed it to be lessened.[5] J. Lehmann noticed that the earthy phosphates were not altered, while the alkaline phosphates were increased, in two out of three experiments, and were, perhaps, increased in the third also. Speck's experiments, which were very elaborate, showed a large increase in the PO_5; and Speck concludes that the quantity of the PO_5 stands in the most intimate relation to the amount of exercise. This is not at all improbable, as the muscles are so rich in phosphates.

8. The chlorine has generally been found to be increased.[6] It falls proportionally afterwards, if food be abstained from. Sometimes, however, when the skin acts very profusely, it would appear that chloride of sodium is excreted in this way,[7] and the increase in the urine is much lessened, or is trifling, or instead of increase there is lessened excretion by the urine.

9. Bases.—Nothing definite is known about the ammoniacal salts. It is to be presumed that the egress of the other bases is augmented, when their acids are increased in amount; in fact, this is certain, from the facts now known on the amount of the free acidity.

10. The free acidity is said, by Professor Lehmann, to be augmented by exercise, from, it is presumed, an augmentation in the sulphuric and phosphoric acids, so that more of the phosphate of

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is really a little benzoic acid in such cases. It may, however, be derived from decomposition of hippuric acid in the bladder.

[1] Vogel in Neubauer's Anleitung, 3d edition, p. 336.

[2] Op. cit., p. 27.

[3] Op. cit.

[4] Archiv des Vereins, Band iv, p. 112.

[5] Nord-See Bad., p. 83.

[6] Hegar, op. cit.; and Beneke, Nord-See Bad.

[7] G. H. Meissner's experiments on the perspiration (Schmidt's Jahrb., 1860, No. 1) seems to show this. So also some of J. Lehmann's experiments (cases 3 and 5), and Speck's, where there was profuse sweating.

soda would be in the form of the acid phosphate than usual. But J. Lehmann's experiments, which were more numerous than those of his celebrated namesake, show that the free acidity is not increased; and therefore the egress of bases must be augmented in the same ratio as that of the acids. After great exercise, the body must, therefore, be poorer in alkalies.

SECTION XI.

SLEEP.

The effect of sleep on the urine is evidently a most difficult problem, as it is almost impossible to eliminate other conditions, the influence of which is very great. Thus, during sleep, the body is generally in perfect rest; the brain is inactive; the heart's action is lessened in frequency, and probably in force; respiration is less frequent, and is less deep; and the skin is usually kept warm. While all these conditions would tend to decrease urinary excretion, the influence of the heavy meals which are often taken during the latter part of the day can be traced during the early part of the night, and have an opposite effect.

It has been generally assumed (possibly from a study of the effects of hybernation), that sleep *per se* lessens the urinary excretion, as it does the pulmonary carbonic acid, according to Prout, Scharling, and Coathope.

This is decidedly asserted by Gunther[1] and by Purkinjé.[2]

On the other hand, Santorini asserts that sleeping men sweat as much in seven hours as waking men in fourteen.

Dr. Böcker[3] has experimented on this point in a method which obviates some fallacies, but seems to admit others. In order to avoid the influence of food, he commenced his experiments twelve hours after a light meal, which was taken at seven p.m. At seven o'clock on the following morning, Böcker passed urine, and then drank 500 c.c. (rather more than a pint) of water. The experiment then commenced, and was carried on for six hours, during which time Böcker tried to sleep as much as possible; sometimes he could not sleep. He then remained in bed for the six hours, under exactly the same conditions as when he slept. The urine secreted during the six hours was, of course, *urina sanguinis,* diluted by the 500 c.c. of water taken at 7 a.m.

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[1] Lehrbuch der phys. des Menschen, 1845, p. 626.

[2] Wagner's Handworterbuch der phys., Band iii, 2d Abtheil, 1849.

[3] Archiv des Vereins fur wiss. Heilk., Band ii, p. 76.

A comparison was then made between the six hours in which any sleep was taken, and six of the sleepless hours; the result was, that sleep was found to augment all the urinary ingredients, with the exception of the uric acid, the phosphoric acid, and the fire-proof salts. The increase in the sulphuric acid was slight, indeed immaterial; that in the urea very great, in fact, enormous, amounting to 50 per cent. over the sleepless period. The decrease in the uric acid was considerable. The decrease of the phosphoric acid amounted to 33 per cent. from one hundred minutes' sleep in six hours. This would seem to show that the disintegration of nervous tissue is lessened during sleep, as the condition of the muscles (the other principal source of PO_5) was the same during both periods (sleep and sleeplessness).

The body lost weight during the six hours, on an average—

Number of experiments.	Average amount of sleep in six hours.	Loss of weight.
		Grammes.
4	102 minutes.	142
4	None.	32

The conjoint exhalation from the skin and lungs was not materially different in the periods.

The experiments of Böcker are of course open to the great objection, that the secretion during the several periods of six hours on successive days may vary considerably, and that comparisons between such periods can only safely be drawn from an infinitely longer series of experiments than those reported by Böcker (eight experiments); the immense increase in the urea may be held to prove almost too much, and to indicate that some unnoticed source of variation must have been acting. The taking also of water just before the period of experiment must be held to be an objectionable plan. On the whole, therefore, judgment must be deferred as to the merit of these experiments, except in so far that they may be held to prove that sleep does not lessen the excretion of urea.

Böcker's experiments are, perhaps, somewhat supported by the facts mentioned by Gruner, Mosler, and Winter. Without especially referring to the influence of sleep, these observers noticed, severally, that the amounts of SO_3, and free acidity, were greater during the night than in the morning hours. Vogel, indeed, refers this to the influence of food; but the principal meal was taken in the middle of the day, and its effect would have passed off before night. The chloride of sodium does not follow the same rule (Hegar).

SECTION XII.

MENTAL EXERTION.

It is a common opinion, that great mental work lessens the weight of the body, though whether it does so by directly aiding metamorphosis, or by merely lessening the vigour of the digestive organs, and the consequent ingress of food into the system, is not yet known.

1. The water.—By carefully noting the amount of urine at periods when the mind was tranquil or active (all other circumstances being taken into consideration), Beneke[1] has determined that mental excitement and intellectual exertion increase the amount of urinary water. Mosler's experiments also favour this conclusion.

If this be correct, it remains to be seen whether the excretion of water from the other emunctories is at all checked; if not, the body must be poorer in water after mental work.

2. The urinary solids.—Hammond[2] affirms that the urea is increased; his experiments were numerous, and seem to be satisfactory, but on so difficult a point many repetitions are necessary. Prout also, long ago, surmised that mental anxiety increased the urea; and Mr. Haughton has come to the same conclusion. Hammond also found the chlorine, sulphuric and phosphoric acids, all increased, but the uric acid lessened. With respect, especially, to the phosphoric acid, Mosler's experiments, though few in number, point to an increase. When examining the hourly excretion, he found the phosphoric acid much higher in the hours when most intellectual exertion was going on, though these were not the hours most affected by food and movement. The amount of increase was—

The total phosphoric acid by one half.
The phosphoric, with alkalies, less than one fourth.
The phosphoric, with earths, nearly one third.[3]

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[1] Studien zur Urologie. Archiv für wiss. Heilk., Band i, p. 571.

[2] American Journal of Med. Sci., April, 1856.

[3] Studien zur Urologie, Archiv des Vereins für wiss. Heilk., Band i, p. 571.

Mosler found the pigment (as estimated by Vogel's method) also increased.

On the other hand, Owen Rees[1] believes that mental labour causes no increase of phosphoric acid, but this statement is not supported by any analyses, showing the absolute amount of PO_5 excreted in a definite time.

The deposit of phosphates, often seen in the urine of nervous and overworked persons, does not prove any increase in the PO_5, but merely that the free acidity is lessened, probably from impaired digestion.

The asserted increase of the phosphoric acid is the most interesting point yet indicated, as, if it be correct, it would probably arise from increased metamorphosis of the cerebral tissue.

SECTION XIII.

MENTAL INACTIVITY.

On this point nothing can be said to be known. Hammond[2] has conceived that mental inactivity has exactly the reverse effect of mental exertion; but his experiments are insufficient. The problem is a most complicated one, and it is much more difficult to ensure a state of mental inertia than of mental activity.

SECTION XIV.

THE CONDITION OF THE OTHER ELIMINATING ORGANS.

The intestines, skin, and lungs are acted upon by a great variety of agencies,—some external, some internal. Their action affects in a very great degree the action of the kidneys.

1. The water.—That the water of the urine is lessened when the cutaneous excretion is active, and is increased in the opposite condition, is an admitted fact. The passage of water from the stomach and intestines has a similar effect. Whether an altered watery excretion from the lungs also affects the water

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[1] Guy's Hospital Reports, 1855, p. 300. A very sound paper, in which the deposits of phosphates are referred to their true causes.

[2] Amer. Journ. of Med. Science, 1856.

of the urine in health, is not, I believe, known. In disease there is some reason to think it does do so.

The effect of external heat on the skin manifests itself at once on the water of the urine.

2. The solids.—A free action of the bowels lessens the urinary solids.[1]

3. The urea.— Strong action of the skin lessens the urea. This is, perhaps, from the flow of water through the walls of the renal capillaries being lessened; or, perhaps, from an increase in the passage of urea through the skin.[2] (See "Temperature.")

Severe purging lowers the urea. Whether this is by absolute exit of nitrogenous compound in this way, or by merely lessening the flow of urinary water, is unknown.

3. The uric acid.—Dr. Marcet (the elder) believed that uric acid was lessened by sweating. Lehmann[3] does not confirm this.

4. Nothing is known of the influence of the action of the other eliminating organs on the hippuric acid, the pigment, and extractives.

5. It is uncertain whether sweating lessens the urinary sulphuric and phosphoric acids, or whether the imperfect action of the skin increases them. Strong action of the bowels lessened, in some of my experiments on patients, the amount of sulphuric acid.

6. The chloride of sodium falls during profuse sweating, no doubt from increased elimination from the skin.[4]

Purging lessens the urinary chloride, as some salt then passes with the stools.

It is to be presumed that inaction of the skin will have the reverse effect. (It has so in diabetes mellitus.) Constipation will have less influence, as so small a quantity of chloride passes off in health from the intestinal mucous membrane.

7. Very strong action of the skin, perhaps, lowers the free acidity; and possibly the alkaline effect of baths is owing to this. But no good experiments have yet been made.

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[1] Böcker, Beitrage zur Heilk., 1849, vol. ii, p. 102.

[2] See the experiments of Funke, Schottin, Wolff on the Skin (Canstatt's Jahresb. for 1857, Band i, p. 80).

[3] Phys. Chem., 2d edit., Band i, p. 218.

[4] Mosler's experiments on the action of water with and without exercise (formerly referred to) prove this, as also do some of the other experiments on exercise.

SECTION XV.

TEMPERATURE (OF THE ATMOSPHERE).

The effect of moderate *cold* is, according to Lehmann, to cause an increase of the urinary excretion (from the action on the skin ?).

Great cold, on the other hand, carried to the point of depressing the nervous system (commencement of the sleepiness), would appear to diminish metamorphosis.[1]

The influence of *heat* has been generally supposed to diminish urinary excretion, by leading to increased action of the skin. That the water is diminished has long been known, and the experiments of Kaupp[2] have clearly proved that this is the case also with the urea. Kaupp's facts may be thus given :

Mean temperature of the air.	Number of experiments.	Mean quantity of urea in 24 hours.		Mean quantity of water in 24 hours.	
		Grammes.	Grains.	c.c.	Ounces.
49° Fah.	10	36·106	557	2430	85
53°	18	35·434	547	2367	83
58°	10	34·061	525	2406	84
63·75′	11	33·836	522	2327	81½
67·5	16	33·862	522	2218	77
71·6	16	33·980	524	2223	77
78	8	33·398	515	1725	60

1. Thus an elevation of temperature equal to 2¼° Fah. reduces, on an average, the quantity of urine by from 60 to 70 c.c. in twenty-four hours. The diminution is not, however, very regular.

2. An elevation of 2¼° diminishes, on an average, the urea by 0·12 grammes, or 1·852 grains, in twenty-four hours.

3. An elevation of 2¼° Fah. causes a diminution in the chloride of sodium, of 0·11 grammes, or 1·69 grains, in twenty-four hours.

4. The other soluble constituents are diminished for every 2¼° Fah. 0·43 grammes, or 6·639 grains, in twenty-four hours.

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[1] Pickford, quoted by Beneke, Archiv des Vereins, Band i, p. 567.
Archiv fur phys., Heilkunde, 1855.

Kaupp is of opinion that the diminution of the water has, as a consequence, the diminution of the urea and of the chloride of sodium; that is to say, he believes these ingredients are not diminished directly by heat, but are lessened only because of the lessened excretion of water.

On the other hand, the other soluble constituents of the urine must be lessened directly by the heat, as their decrease is too great to be accounted for by the decrease of the water.

It is, of course, presupposed in these experiments that all other conditions except temperature remain rigidly equal. The amount of food and of water taken by persons varies so much, and the amount of exercise is so different, that the influence of heat is constantly more or less neutralized by other agencies.

Sick[1] has confirmed Kaupp's statement, as far as the water of the urine is concerned. The diminution was slightly greater, being 98 c.c. in twenty-four hours for every 2¼° Fah.

Ranke[2] has not found any influence on the uric acid.

SECTION XVI.

PERIOD OF THE DAY AND YEAR.

The effect of *different periods of the day* has been already discussed in previous chapters; for the variations in the urine at different times are dependent chiefly on food, exercise, temperature, sleep, and the other conditions already noticed. As the principal meal is taken in the afternoon or evening, and as the effect of exercise is then most discernible, the quantities of all the ingredients are usually highest in the afternoon and evening, and in spite of the counteracting influence of sleep, sink during the night, with the exception of the chloride of sodium (Hegar), which reaches its minimum in the hours of the forenoon.

Kaupp[3] has found, in his own case, that there is during the night an enormous decrease in the excretion of the chloride of sodium, and as great an increase of phosphoric acid. The quantity of the urine, and the amount of urea, diminished like the chloride of sodium, but not to an equal extent.

J. C. Draper[4] found the amount of urine nearly equal in the day and night, but the amount of urea was about one seventh less in the latter period.

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[1] Archiv fur phys. Heilk., 1857, p. 482.

[2] Ausscheidung der Harnsaure, p. 8.

[3] Vierordt's Archiv, 1856, p. 556.

[4] New York Journal of Medicine, 1856.

The acidity is especially low in the morning.

Kaupp's experiments prove that there is a kind of antagonism between the excretion of the day and night. If the former is unusually profuse, the latter diminishes; and the reverse.

As compared with the insensible perspiration (skin and lungs), the urine was found by Gross to be comparatively less during the night, and greater in the morning.

In the "Gulstonian Lectures" for 1855,[1] I stated that some observations led me to believe there was a kind of periodical wave of gradual increase and decrease of urinary excretion extending over two or three days. My experiments are not yet sufficiently complete to allow of citation; but I again mention the statement here, as from an analysis of Kaupp's experiments, Professor Radiche[2] has indicated an analogous fact, and Vierordt[2] has also noticed a "two days' periodicity," often in an undoubted manner.

With respect to *the time of year*, Professor Vogel has proved by experiments,[3] what universal observation had previously affirmed, that in the cold months, when the skin transpires little, the water of the urine increases.

The effect of heightened temperature on the urea, &c., has already been noted.

Fourcroy thought the uric acid was increased in winter. Lehmann does not confirm this; and Ranke's experiments[4] show little difference between summer and winter.

The effect of continued cold, however, on the urine has not been perfectly investigated. The effect of diet, dress, exercise, and atmospheric conditions, must be accounted for.

Changes of season must affect the urine by alterations in temperature, and perhaps of atmospheric humidity and pressure; but it remains to be seen how far the appliances, the abundant clothing and the artificial warmth, of modern life neutralize the effect of these changes.[5]

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[1] Med. Times and Gazette.

[2] Archiv für phys. Heilk., 1858, p. 207 and p. 227.

[3] Vogel, in Wagner's Handworterbuch, 1st edit., p. 264.

[4] Ausscheidung der Harnsaure, p. 8.

[5] Schweig asserted that the uric acid altered with the changes of the moon, but the variations he notes are less than the errors of the method employed. See Ludwig's Phys., 1st ed., Band ii, p. 262.

SECTION XVII.

CLIMATE.

Scarcely any experiments have yet been made to show the influence of climate on the urine. The effect of temperature in the tropics would probably be analogous to its action in temperate zones; and the study of this point will doubtless throw eventual light on many of the diseases which affect Europeans on their first entrance on tropical life.

It has been affirmed by Schultens, on apparently insufficient grounds, that the uric acid is increased in Holland, where the air is very moist. A series of comparative experiments in the dry and rainy seasons of India would certainly lead to some interesting results.[1]

SECTION XVIII.

COMPOSITION OF THE BLOOD.

Most agencies act through the blood on the kidneys, and the composition of each fluid must be, to a considerable extent, an index of the composition of the other. At present, however, we are uncertain how far this is the case, as few comparative analyses have been made. That an excess of water or of salts in the blood leads to excess of urinary water or salts,[2] that excess of albuminates (fibrine?) leads in most cases to excess of urea and uric acid (not by immediate oxidation, but by action on the organs?), and that any peculiar destruction of red particles is evident by a corresponding increase in urinary pigment, and a few other facts of a like kind, comprise all that is known at present,

Mosler[3] has endeavoured to determine the relative amounts of the red particles in the blood (as counted by the method of Welcker), and of the urea and other constituents in the urine.

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[1] The influence of heat and cold on the skin in the production of disease among the English in India, and on invalids of the Indian service, has been well discussed by Sir Ronald Martin (Influence of Tropical Climates).

[2] Hermann (Virchow's Archiv, Band xvii, p. 451) has lately contradicted the statement of Kierulf, that a great amount of water in the blood produces at once albuminuria. It never does this without local kidney injury (excessive pressure).

[3] Corr. Blatt des Vereins für wiss. Heilk., No. 25.

The experiments were made on a boy, a man, and two young women. The results were indecisive, as it was impossible to compare the two cases with each other, except in the instance of the two women; the woman with the greatest amount of blood corpucles excreted more urea, pigment, and sulphuric acid than the other, but less PO_5 and chloride of sodium. These experiments can be considered only as the commencement of this difficult inquiry.

In animals, when a very great amount of fluid is added to the blood, bile pigment can be detected in the urine (Hermann).[1] So also when the dilution reaches a very high point, hæmatin passes from the blood-cells into the serum, and then into the urine; the walls of the glomeruli being more permeable for this substance than for serum-albumen. Whether this can occur in men, from excessive water-drinking, is unknown.

SECTION XIX.

THE ACTION OF THE HEART.

The action of the heart must affect greatly both the rapidity of circulation, and the pressure on the renal vessels. That it is overruled by other agencies (nervous?) is shown by the fact that the two kidneys do not excrete with an equal rapidity, but that their action alternates to a certain extent, as if their vessels were alternately more or less contracted or dilated. For the full discussion of this difficult subject, I must refer to physiological works, and shall here merely content myself with the general statement, which seems, on the whole, to be warranted by the observations of Ludwig, Goll, Dornbluth, and Heynsius, that, other things being equal, a strongly beating heart will furnish urine more abundant in water, and richer in solids, than a feeble heart. In health, however, the effect of the varying action of the heart is certainly not very apparent.

SECTION XX.

ACTION OF THE NERVOUS SYSTEM.

The experiments of Bernard,[2] Ludwig, Brown-Sequard, Schiff, and others, on dogs and rabbits have shown how remarkably the secretions of many glands are affected by injuries and irritations of the nerves. The kidneys are no exception.

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[1] Hermann thinks this is derived from the hæmato-globulin, the hæmatin being in fact transformed into bile-pigment.

[2] See especially Bernard, Leçons, Band ii, p. 153.

Saccharine urine is produced by irritation of the base of the brain, especially of the fourth ventricle, of the upper part of the cord, and of the sympathetic. The action of the kidneys is here merely secondary; more sugar is formed in the liver than can be destroyed, and it therefore emerges by the urine.

Albuminous urine is caused by injury of the sympathetic in the neck (Bernard); but the exact mode in which it is produced is uncertain.

Excessive flow of urinary water (diabetes insipidus) is also produced by injury of the sympathetic in the neck (Bernard), and results, perhaps, from dilatation of the renal vessels, produced by paralysis of the constrictor nerves, or by increased action of the nerves, which, in some unexplained way, causes dilatation of the vessels. The result is the same in the case of the kidney as in the salivary gland.

It is to be presumed that the nervous and excreting systems of man are governed by similar laws; and, indeed, we know that saccharine urine is sometimes produced by injuries at the base of the brain (and of the spine?). Whether albuminuria in man ever arises from disease of the nervous system, is unknown; but there are some indications that diabetes insipidus is really produced by some nervous conditions, similar, perhaps, to those caused in dogs by actual experiment. In the temporary diabetes insipidus of hysteria, epilepsy, &c., the same condition may be present, and possibly it will be found to be produced simply by altered contractility of the renal vessels.

But this subject is evidently too little advanced to permit any profitable discussion.

Beneke,[1] from observations on himself, has noticed that when the nervous system is, so to speak, in good tone, *i. e.*, when there is a feeling of vigorous health, and when all the functions are rightly performed, the amount of urine (and of urea?) increases. On the other hand, when there is langour and depression, the urine is less in amount. The difficulty here, of course, is to define the term "tone of the nervous system." That something real is meant, is certain; and the immediate influence on the amount of the urine of this state is, I think, put beyond doubt by Beneke's elaborate inquiry.

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[1] Archiv des Vereins für wiss. Heilk., Band i.

SECTION XXI.

INDIVIDUAL PECULIARITY.

If it were possible to place two individuals, of the same sex, age, and weight, under precisely equal conditions of food, exercise, rest, external temperature, &c., would the urinary excretion be the same in each person? In the same individual, the equalisation of all the conditions certainly tends to render comparatively stable the urinary excretions from day to day; but then, in the case of another person, some differences exist which cannot be done away with or compensated.

Individuals differ—

First, in the comparative action of the different excretion organs; so that in one person more work is done by the kidneys, in another by the skin, or lungs, or bowels. To take one illustration from some analyses by Hegar. Two persons, on the same diet excreted of chloride of sydium the following amounts:

	Age.	Height.	Weight.	ClNa in 24 hours.
H	. 24	. 177 ctm.	. 126 lbs.	. 10·32 grammes.
G	. 24	. 176 „	. 124 „	. 7·38 „

Either the food was very different in composition or quantity (which does not appear), or the chloride of sodium passed off, in the case of H, more copiously by the kidneys, in G by the skin.

The same is the case with the water. The phosphates again, in some persons, are probably excreted more largely by the bowels. This may be the case with the SO_3, as I think that rather free, healthy intestinal action lessens the urinary SO_3; and we know, from Marcet's observations, that sulphur passes in the stools. In the case of the urea, too, it is not at all impossible, that in some persons more may be excreted by the skin, and comparatively less by the kidneys; but the facts are not sufficient to prove this at present.

Secondly, in the metamorphosis of tissue. Thus, it seems quite clear that the amount of uric acid differs remarkably in different persons, and is not so much influenced by weight as the other ingredients. It seems almost certain that some persons naturally make more uric acid (and less urea?) than others; so that no equalisation of food and other conditions would render the urinary composition of such persons equal to that of others.

This may, possibly, be the case also with the hippuric acid, as the few analyses yet made show great differences in amount.

Again, it remains to be seen whether, in some persons, more of the nitrogen does not pass off by the lungs (as ammonia), than in other persons; if this turn out to be the case, no regularity of diet, exercise, &c., could render the urea the same in two persons of equal age, sex, and weight.

Altogether it would seem probable, that if two individuals, of the same sex, age, and weight, took precisely the same food, exercise, rest, and were subjected in all points to the same conditions, the urinary excretion would not be equal.

SECTION XXII.

MENSTRUATION.

Beigel[1] has made some rather imperfect observations on this point. In two women the following amounts were found:

	Before menstruation.		During menstruation.		After menstruation.	
	Water.	Urea.	Water.	Urea.	Water.	Urea.
Woman, aged 30...	898	27·17	954	24·70	997	28·39
Woman, aged 19...	749	25·23	847	22·03	882	27·62

If the result in these two women can be taken as the rule, which is very doubtful, the amount of urea is lessened *during* but increases *after*, menstruation. I am not aware of any other analyses.

SECTION XXIII.

PREGNANCY.

The urine of pregnant women was said by Lubansky[2] to be less acid than usual; Lehmann[3] finds, however, that when first passed it is equally acid, but has a greater tendency to become alkaline than the urine of non-pregnant women. Hofle[1] has not, however, found even this to be the case.

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[1] Op. cit., p. 26.

[2] Quoted by Hofle, op. cit., appendix, p. 159.

[3] Ibid., p. 160.

Towards the latter end of pregnancy, the urine becomes more watery; all the solids diminish in amount, except, according to Böcker, the volatile salts and extractives. The earthy phosphate was said by Carus and Lehmann to be especially diminished. Böcker's analyses do not show this to any great extent; but Hollmann confirms Lehmann's statement.

The following table, from Böcker's analyses, gives the most complete statement of the urine of pregnancy yet made.

Urine of a Pregnant Woman in perfect health.

Day of month.	Period of pregnancy.	Urine of 24 hours; in cubic centimeters and grammes.								
		Urine.	Water.	Solids.	Urea.	Uric acid.	Mucus.	Fireproof Salts.	Earthy phosphates.	Volatile salts and extractives.
		c.c.	c.c.	grms.						
12th Feb. .	End of 8th week	1206	1162	43·41	15·92	0·78	0·12	18·34	1·14	8·29
13th March	„ 12th „	2635	2560	74·04	16·03	0·13	0·21	34·20	1·58	23·46
16th April.	„ 17th „	1783	1732	50·31	13·27	0·35	0·31	20·32	1·09	16·04
19th May .	In the 22d „	1432	1389	42·31	9·44	0·28	0·53	16·15	0·98	15·94
14th June .	End of 26th „	1382	1330	50·56	15·94	0·46	0·17	19·59	1·39	14·38
26th „ .	„ 28th „	1300	1259	40·30	9·10	0·52	0·13	18·20	1·17	12·35
22d July .	„ 32d „	1401	1354	46·09	9·37	0·86	0·14	17·34	1·08	18·87
21st August	„ 36th „	1093	1049	43 37	7·44	0 44	0·13	18·82	1·00	16·52
5th Sept. .	„ 38th „	1447	1405	41·71	10·46	0·42	0·17	12·58	1·02	18·06
13th „ .	In the 39th „	1564	1520	43·54	7 69	0·39	0·17	17·20	1·22	18·08
21st „ .	„ 40th „	1432	1393	38·33	6·84	0·21	0·18	14·24	1·11	16·84

During this period, the weight of the woman increased about 5400 grammes.

One Kilogramme of Body-weight excreted.

	Water.	Solids.	Urea.	Uric acid.	Mucus.	Fire-proof salts.	Earthy phosphates.	Volatile salts and extractives.
At end of 8th week	29·85	1·11	0·408	0·018	0·0031	0·471	0·029	0·213
At the 40th week .	31·38	0·86	0·154	0·004	0·0040	0·320	0·025	0·379

The most noticeable fact brought out by this is the great diminution in the urea. It fell from 0·408 grammes to the kilogramme, which may be considered a healthy amount, to

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[1] Wagner's Handworterbuch der Phys., op. cit.

[2] Böcker, Rheininche Monatschrift für prak. Aertze, May, 1848, p. 129.

0·154 grammes. The uric acid was also lessened. The earthy phosphates were scarcely altered.

An analysis, by Hollmann,[1] was made of the urine of a woman, aged thirty-one years, who had had four children, and who was in the thirty-fifth week of pregnancy. The singular deficiency of "extractives" in the first analysis is worthy of note. The amount gradually increased. The urea in this case was apparently not lessened, but the phosphoric acid was decidedly so.

In twenty-four hours there were excreted in grammes—

	10 July. First analysis.	14 July. Second analysis.	20 July. Third analysis.	25 July. Fourth analysis.	3 Aug. Fifth analysis.	7 Aug. Sixth analysis.	9 Aug. Seventh analysis.	18 Aug. Eighth analysis.	Mean.
Quantity . .	1625	2150	2135	2020	1860	1570	2220	1425	1876
Water . .	1579·569	2099·475	2089·098	1964·450	1807·920	1531·928	2160	1374·38	1825·8
Solids . .	45·431	50·525	45·902	55·550	52·080	38·072	59·94	40·612	48·514
Organic solids .	22·888	25·800	22·417	28·280	29·760	19·625	35·520	27·787	26·509
Urea . . .	22·750	24·366	20·015	24·452	23·495	19·004	28·04	21·899	23·003
Extractives .	0·138	1·434	2·402	3·828	6·265	0·621	7·480	5·888	3·507
Inorganic salts .	22·543	24·725	23·485	27·270	22·320	18·447	24·42	12·825	22·004
Chloride of sodium	11·736	16·720	11·849	16·160	13·432	13·082	16·525	7·915	13·427
Sulphuric acid .	2·112	2·580	2·092	2·222	2·232	1·664	2·486	1·995	2·173
Phosphoric acid .	0·812 (earthy salts.)	2·365	2·290	2·141	1·674	1·413	1·554	0·570	1·706

Mosler has made twelve observations on the twenty-four hours' urine of pregnant women, the mean of which is as follows:

Quantity	1488	c.c.
Urea	26·193	grammes
Chlorine	7·930	„
Sulphuric acid	1·250	„
Pigment (determined by Vogel's method) .	7·930	„

The phosphoric acid was found to be—

	Per hour.	In 24 hours.
PO_5 to alkalies . . .	0·064	1·430
PO_5 to earths . . .	0·024	0·576
Total PO_5	0·088	2·006

These analyses do not show any diminution either in the urea or phosphoric acid.

Blot[2] has found sugar in the urine of pregnancy, as in that of suckling. This is denied by Wiederhold and Leconte (Schmidt's Jahrb., 1858, No. 1, p. 14); for a discussion on this subject I refer to the chapter on "Suckling."

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[1] Einige Untersuchungen über Blut u. Harn. der Schwangeren. Inaug. Diss. Wurzburg, 1854. In Scherer's Report on Pathol. Chem., Canstatt's Jahresb. 1854, p. 187.

[2] Comptes Rendus, 1856, ii, No. 14.

Ranke[1] examined the water, solids, chlorine, urea, and uric acid in a woman, twenty-five years old, confined with her first child. From a comparison of five days before the birth, and six days afterwards (beginning with the second day), it would seem that before labour the excretion was very regular, and was normal as to quantity, the mean being in twenty-four hours—

Water	916	c.c.
Solids	46·21	grammes
Urea	23·82	„
Uric acid	0·512	„
ClNa	8·08	„

after the birth, all the above urinary ingredients were very much lessened for a day, and then increased, so as to very much surpass the excretion before the birth. Taking the five days (4—9) after birth, the mean excretion in each twenty-four hours was—

Water	1520	c.c.
Solids	54·14	grammes
Urea	33·35	„
Uric acid	0·483	„
ClNa	5·46	„

The water and urea were thus increased, especially the water, while the uric acid was almost unaltered, and the chlorine was lessened. The increase in the urea may be connected either with the rapid disintegration of the uterine textures (as suggested by Ranke), or, perhaps, with a slight pyrexia occurring during the first week.

All these analyses can be merely considered as so many facts, which future observations must confirm and connect together, but which are not at present susceptible of being used to explain the metamorphoses in pregnancy.[2]

Much attention was directed some years ago to the formation of a white scum, or thick pellicle, which appears in the urine of pregnant women, when kept for thirty or forty hours, and to which the term kyestein was applied.[3]

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[1] Ausscheidung der Harnsaure, p. 20.

[2] Comparative analyses of the blood and urine of a pregnant woman with dropsy and albuminuria have been made by Harley and Gegenbam. (See chap. v.)

[3] For the voluminous literature on this point, see Hofle, Chem. und Mikroscop. am Krankenbette, 1st edit., appendix, p. 149.

The last and best paper is by Elliott (New York Journal, Sept., 1856). He describes the appearances in 153 cases of pregnancy.

It was supposed that this substance was in part composed of casein, derived from the mammary gland; but this does not appear to be the case. The so-called kyestein is not of constant or determined composition, but consists of triple phosphate, derived from decomposition of the urea, bladder mucus, fat, infusoria, and fungus-growths, mixed with the organic matter of vaginal discharges. Very similar appearances are found, less frequently, in the anæmic urine of non-pregnant women, and sometimes in the urine of men.

As already said, according to Blot,[1] when the breasts begin to enlarge during pregnancy, sugar appears in the urine, and continues during the whole period. No other diabetic symptoms attend this state. (On this subject, see page 107.)

When albuminuria and dropsy occur in pregnancy, the amount of urea is very much lessened. Harley and Gegenbaur[2] have made comparative analyses of the blood and urine of a woman, aged thirty-six, who, in the thirty-third and thirty-fifth weeks of pregnancy, had general dropsy and albuminuria, but improved before delivery, and got perfectly well afterwards.

The blood was found in the first two analyses to be very watery (826 and 829½ parts per 1000), and to be poor in albumen (54 and 60·6 parts per 1000) and in blood-cells (103·5 and 96 parts per 1000). The soluble salts were in excess. The fibrine was in normal amount. Subsequently the blood became much richer in albumen and red cells; indeed, quite normal. The urine had the following composition in twenty-four hours, in c.c. and grammes:

	Water.	Solids.	Urea.	Albumen.	Extractives.	Fixed salts.
First analysis (33d week); blood watery, albumen small ...	1169	43·25	4·01	11·19	1·17	26·88
Second analysis (35th week); blood watery; albumen small, but less so	1668	48·37	9·18	5·00	7·49	26·70
Third analysis (after delivery); blood much more healthy ...	1792	58·70	19·60	3·28	5·73	31·01

The increase of the urea and the "extractives," and the decrease of the albumen, coincidently with the improved condition of the blood, are very well seen. The quantity of the salts appears to have been great, but the patient was taking some saline medicines.

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[1] Scherer's Report on Phys. Chem., Canstatt's Jahresb. for 1856, p. 160.

[2] Scanzoni, Beitrage zur Geburtskunde.

SECTION XXIV.

DELIVERY AND SUCKLING.

The only examination of urine immediately after delivery is that quoted from Ranke, in the previous chapter.

According to Blot,[1] the urine of women, not only during pregnancy, but after delivery and during lactation, contains sugar, which is usually in proportion to the amount of milk, and lasts as long as this is formed—in one case even for twenty-two months. The amount is said to be from 1 to 12 grammes in 1000 grammes of urine, and it is not only not increased, but is lessened by pathological processes diminishing the flow of milk. These statements have not been confirmed. Kirsten, from the examination of 100 cases, found that in pregnant women, and after delivery, sugar can sometimes be found, but always in very small quantity. In the urine of suckling women it is usually found, if either the flow of milk is lessened by some pathological process (as noticed already by Lehmann), or by the child being removed. Heynsius[2] has also investigated this point, and has arrived at a different conclusion. In sixty cases of pregnant and suckling women, he found invariably in the urine a substance which, at a great heat, reduces the copper solution, but had no effect on the saccharometer, and could not be fermented. He succeeded in partially isolating this substance, which he considers not to be sugar. He does not, indeed, appear to have found sugar in any of the cases. The experiments of Wiederhold and Leconte[3] confirm the statements of Heynsius: according to the former, the substance reducing the copper is mucus; according to the latter, it is uric acid. Bonnet and Meissner[4] confirm the statement that uric acid will reduce the copper solution, while at the same time Meissner[5] and Von Babo were unable to detect sugar in the urine of suckling women and of suckling beasts. Zwenger (Meissner's Report, 1857, p. 336) has also shown the absence of sugar in the alcoholic extract of the urine of suckling women.

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[1] Comptes Rendus, 1856, quoted by Meissner, Report on Phys. in Henle's Zeit. für Rat. Med., p. 227; and by Scherer, in his Report on Phys. Chem., in Canstatt's Jahresb. for 1856, p. 161. The experiments were made with the copper test, fermentation, and polarization.

[2] Schmidt's Jahrb., 1857, No. 11, p. 185.

[3] Archiv für die Hollandischen Beitrage zur Heilkunde. Von Donders und Berlin, 1857, Band i, p. 252.

[4] Schmidt's Jahrb., 1858, No. 1, p. 14.

[5] Meissner's Report on Phys., 1857; Henle's Zeitsch., 1858, Band iii, p. 335.

The truth appears to be that sugar is occasionally present, but is not common; but that, possibly, there may be some increased quantity of mucus which acts on the copper solution; or that, in some cases, a large quantity of uric acid has this effect.

SECTION XXV.

RETENTION OF URINE IN THE BLADDER.

Orfila first indicated the fact of absorption from the bladder; and Kaupp[1] has lately endeavoured to prove, by a careful series of experiments, in which all possible fallacies seem to be excluded, that the urinary constituents are really absorbed again when the urine is detained in the bladder. The water is most easily taken up; then the phosphates, the chlorides, and lastly the sulphates. The urea is much less largely absorbed, but yet diminishes to some extent. These observations are partly confirmed by some experiments by Wundt, which will be referred to in the section on "Hydro-therapeia."

SECTION XXVI.

CHANGES OCCURRING IN THE URINE AFTER EMISSION.

In the acidity.—From the beautiful researches of Scherer, we know that, in most cases, the acidity increases after the urine is passed. This increase may go on from two to five days, or in rarer cases may continue for several weeks. It is generally, but not always, most marked in the dark-coloured and concentrated urines, and is supposed to depend on oxidation of the pigment. Virchow has suggested that it is produced by changes in the substance, which, on oxidation, becomes indigo (Heller's uroxanthin). The acid thus produced is probably the lactic; but it has been supposed that acetic (Liebig), butyric, metacetonic, and even oxalic (Zimmermann), may be thus formed. The amount of acid is often enough to take alkali from uric acid, which then precipitates. Coincident with this increase of acidity, fungi often appear (penicilium glaucum, Hassall).

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[1] Vierordt's Archiv, 1856, p. 125.

After remaining acid for a variable length of time (sometimes for many weeks), the urea begins to decompose into carbonate of ammonia, the free acid is neutralized, the urine becomes alkaline; the uric acid is dissolved, or more often forms globular urate of ammonia, which dissolves with difficulty; phosphate of lime and ammoniaco-magnesian phosphate are precipitated; the fungi lessen, and vibriones appear.

These changes are sometimes called the acid and the alkaline fermentation.

In some urines there is no acid fermentation, but the decomposition of the urea commences early. This occurs chiefly when the pigment or uroxanthin (?) is in small amount, and the urine is watery and of feeble acidity, or when there is much mucus and epithelium from the bladder.

SECTION XXVII.

In the preceding sections I have enumerated the various conditions which produce deviations from the normal mean excretion of any individual. In logical order, I ought now to estimate the respective effects of these conditions, when two or more are acting simultaneously, and augment or antagonise each other's action. For example, a man may, at the same time, take an excess of nitrogenous food, and of water, and of exercise—three conditions which augment the formation and elimination of urea; while he may also take alcohol, tea and coffee, and be subjected to the influence of high external temperature—three conditions which lessen the formation or elimination of urea by the kidneys. But I conceive our knowledge of the relative powers of these physiological conditions to be so imperfect as to render a profitable discussion impossible; and I could say nothing more here than can readily be inferred from what has gone before.

Here also would be the place to enter on the subject of the origin of the urinary constituents—a topic already alluded to in the Introduction. But, I conceive, as much has been said as our knowledge at present admits, and as the plan of this work allows.

I cannot, however, pass over in silence a very ingenious essay, by the Rev. Mr. Haughton, which may be considered as the commencement of the exact investigation of a part of this subject.[1]

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[1] On the Natural Constants of the Urine of Man. By the Rev. S. Haughton, F.R.S. Dublin Quarterly Med. Journal, August, 1859 and 1860.

In discussing the origin of the urinary constituents, we may attempt to exactly define the parts or tissues furnishing them, and to estimate the exact share taken by each part. For example, phosphoric acid (besides coming at once from food) is furnished by the disintegration of almost all parts, but especially by the nervous tissue, the muscular tissue, and the bones. The result is an excretion of some 50 grains daily in the urine, and some in the fæces. We may attempt to distribute these 50 grains to their several origins, and to say, so many grains come from the brain, so many from the muscles, from the bones, or from other parts. In reality, however, such an attempt would be quite premature.

Mr. Haughton, in his very able papers, has adopted another plan. Let us look at the body as an agent performing a certain amount of work, which work is attended by disintegration of tissues, and is represented by the excretions resulting from such disintegration. Now, the work done in the body may be of various kinds: there goes on, for example, constantly a certain amount of tissue change, which is absolutely necessary and essential to vitality. If a man is kept perfectly quiet, not moving, and, if possible, not thinking, his tissues will furnish a certain amount of an excretion, say of urea. This necessary tissue change is called, by Haughton, " vital work," because it is indispensable to life. But if this man, instead of remaining tranquil, undertakes hard bodily labour, there is greater tissue change and greater formation of urea. Now, how much urea is owing to the "vital work," and how much to the "mechanical work"? Again, Mr. Haughton thinks that the action of the mind causes increased disintegration of the body generally, and furnishes urea. If the mind, then, is acting, how much is its contingent of urea?

Mr. Haughton believes that all the work done in the body may be divided into four divisions—

1. Vital work,
2. Mechanical work,
3. Mental work,
4. Calorific work;

and that the excretions measure or represent the amount of work.

Mr. Haughton has as yet only discussed one excretion—urea, which is assumed to be a product of vital, mechanical, and mental work, but not of calorific work. He has determined the amount of urea excreted on a single day by different individuals, and has then analysed carefully the food taken on that day; and has determined, as far as can be done, the amount of mechanical and mental work performed on the same day.

It may be objected to these researches, that, considering the very various circumstances which affect the excretion of urea, a single day's observation is not enough. A more important objection is, that Mr. Haughton has been obliged to assume (for his arguments cannot be said to advance the subject beyond assumption) that all the nitrogen actually used in the work of the body is eliminated as renal urea; a statement apparently incorrect as regards man, however true it may be for dogs and cats. Again, it must be held to be quite uncertain, at present, whether or not mental work furnishes any urea. Mr. Haughton's case is certainly not proved on this point. Moreover, the division into vital and calorific work may be objected to.

Yet, with all these objections, the experiments are of great interest. I can give here merely the results, and must refer to the papers for the calculations and methods employed.

Mr. Haughton calculates that the tissue changes necessary to life furnish in twenty-four hours two grains of urea for every pound weight of the body; and that, if the body is kept quite still, food is taken in quantity sufficient to supply this loss. A man weighing 150 pounds would, therefore, pass 300 grains of urea in twenty-four hours; and this amount is necessary to keep him alive, or, at any rate, healthy.

The man may, however, be employed in some manual work. The mechanical work performed by the muscles, by means of a well-known formula, may be expressed by saying, that a man performing such and such a labour does what is equivalent to lifting so many tons so many feet in a day, or to walking so many miles in a day. Mr. Haughton calculates that the force which is equivalent to raising 100 tons one foot high in twenty-four hours leads to a disintegration of tissue equal to 38·69 grains of urea. If a man weighing 150 lbs. performs an ordinary day's work, which is equivalent to raising about 258 tons one foot high, he will pass 100 grains of urea in addition to the 300 grains which was derived from the necessary metamorphosis of tissue.

With respect to mental labour, Mr. Haughton believes, that an hour's severe study leads to the formation of 43 grains of urea; and lighter mental work, to the formation of 27·71 grains. The arguments he brings forward in support of this fact and these numbers do not appear to be sufficient.

Let us admit, however, the food being put out of the question, that the urea arises from—

1. Vital work,
2. Mechanical work,
3. Mental work;

and that a man of 150 lbs. weight has bodily labour equivalent to lifting 200 tons one foot daily, and moderate mental labour during the day taken as equivalent to two hours' hard study. Then—

				Urea, grains.
1. Vital work . .	150	× 2	grains of urea	= 300
2. Mechanical work	38·69	× 2	„	= 77·38
3. Mental work .	43	× 2	„	= 86
Total urea passed in 24 hours . .				463·38

To cover this loss he will require a proportionate amount of nitrogen, and he will take food to this amount; so that the body will remain exactly at the same weight.

Mr. Haughton's conclusions will be best given in his own words:

"1. The quantity of urea passed per day by men in health varies with their food and occupation, the latter being the principal cause, and regulating the other."

"2. Men employed only in manual or routine bodily labour are sufficiently well fed on vegetable diet, and discharge on an average 400 grs. of urea per day, of which 300 grs. are spent in vital, and 100 grs. in mechanical work. This conclusion is in conformity with the experience of the mass of mankind employed in manual labour in all ages and countries."

"3. When the work is of a higher order, a better quality of food must be supplied, sufficient to allow of a discharge of 533 grs. per day of urea, of which 300 grs., as before, are spent in vital work, and 233 grs. in mental work and the mechanical work necessary to keep the body in health."

"4. The quantity of urea discharged per day varies also with the weight of the individual, which influences the vital and mental work."

"5. The habits, weight, and occupation of the individual enable us to account for a range of the diurnal quantity of urea, varying from 300 to 630 grs. per day; and this discharge may be confidently predicted, when the habits and weight are known."

Mr. Haughton promises some further experiments on the phosphoric and sulphuric acids, the estimation of which, however, will be still more difficult than that of the urea, as so much enters preformed into the body. Still, these investigations, though only approximative, are of the highest interest.

CHAPTER II.

ON THE VARIATIONS IN THE URINARY EXCRETION, DURING HEALTH, FROM THE USE OF MEDICINAL AGENTS.

It need scarcely be remarked how important it is to know the action of remedies on the body in health. In disease, it is true, their action would not be necessarily the same, for pathological processes may modify or supersede the effects which medicines produce in health; but it is obvious that the knowledge of the action in health is an important preliminary to the study of the effects of medicines in disease.

In this inquiry, as in all other parts of the subject, it is extremely desirable that attention should not be fixed only on one excretion, but that the pulmonary, cutaneous, and intestinal discharges should receive an equal and simultaneous investigation. Little, however, has yet been done, except in the case of the urine, though the observations of Schottin, Funke, and Meissner, on the perspiration, of Edward Smith on the pulmonary carbonic acid, and of Marcet on the intestinal excreta, show that we are on the point of acquiring some trustworthy information on these points.

In examining the action of medicinal agents on the urine, two modes may be adopted. By the first mode, the physiological excretion of the kidneys during a certain number of days (not less than six certainly, perhaps not less than ten) is determined, and then, all conditions being kept as equal as possible, except that a medicine or external application is used, the composition of the urine is analysed during a subsequent equal number of days. The differences are put down to the medicine, if such differences fall beyond the limits of error,[1] and if no other cause of variation can be made out.

A second plan consists in keeping the body at a given time under the same conditions (without food, in rest, &c.), and analysing the urine from hour to hour, until the composition is found to become, as it will do at a certain time, tolerably stable; a medicine is then taken, or some hygienic measure is adopted, and any differences in the composition of the urine during the next few hours, which could not be produced by physiological conditions, are put down to the newly acting agency. This method supposes that the action of the agent is rapid. It is a useful mode in connection with the former method.

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[1] In calculating the mean results, the rules laid down by Radiche (Archiv für phys. Heilk., 1858) should be attended to. The sources of error are, of course, extremely numerous, as it is impossible to keep all the physiological conditions perfectly equal.

In both cases it is extremely desirable that the experiments should be repeated many times, and on different persons, so as to neutralize, as far as may be, the very numerous causes which may perhaps be acting, and which may be overlooked or be completely occult.

It must be admitted, that at present the experiments on no single medicine have been made sufficiently often, and there are few statements in the following pages which can be considered as proved in the true scientific sense of the word. Still, much has been done to prepare the way, and to commence the necessary accumulation of evidence.

I have contented myself with stating the result of the observations on the urine, and sometimes on the other excretions, without attempting to explain the action of remedies. This could only be done by entering fully into all the results produced by a medicine on the body; and to do this would be to enlarge this work into a treatise on therapeutics. I have adopted the arrangement which seems most simple and most useful; but I have not enumerated the several constituents of the urine, unless something has been made out about them. When constituents are left unmentioned, it is to be concluded that I am not aware of any facts bearing on the point. In this chapter, as in the former one, I have not referred to per-centage determinations, but only to the amounts excreted in a definite time; generally, in twenty-four hours.[1]

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[1] It may be desirable to mention that the term "insensible perspiration" is now usually employed to signify the conjoint excretions of the skin and lungs. It is generally estimated in this way. The person experimented upon is weighed in as fine a balance as possible. During the course of the experiments, all food and drink are weighed, so that the additions made in this way to the weight of the body are known. The urine and the fæces are separately collected, and measured and weighed. At the end of the experiment the person is weighed again, and then, by a simple comparison of the difference in weight at the beginning and at the end of the time, and of the amount taken in on the one hand, and excreted by the kidneys and intestines on the other, it is at once seen what must have been the amount of the excretions passing off from the skin and lungs. This is the "insensible perspiration or evacuation;" and how much is to be attributed to the skin, and how much to the lungs, is only known by further operations.

SECTION I.

INHALATION OF GASEOUS SUBSTANCES.

1. The extraordinary tonic and alterative effect of *Sea Air* on the inhabitants of inland places is well known, and entitles "sea air" to be classed among remedial agents, rather than among ordinary physiological conditions. The customary and obvious effects of the sea air are an increase of appetite and a gain in weight. Some years ago, when visiting Margate, Dr. Beneke was extremely struck with the great improvement in nutrition and hæmatosis produced in scrofulous children, and he determined to investigate more closely than had yet been done the causes of an improvement so marked.[1]

He commenced his experiments by determining, as accurately as he could, the amount of the ingesta and egesta in himself, while resident in an inland town (Oldenburg). He then went to Wangeroge (on the North Sea), continuing his observations, and following, as far as he could, the same mode of life. He found his appetite increased, he took more food, and he gained weight.

The examination of his urine led him to believe that the cause of the increased appetite was a more energetic change of tissue, which lead to an increased formation of urea and sulphuric acid—the two urinary ingredients which measure most fully the disintegration of nitrogenous and sulphur-holding tissues. This increased metamorphosis would, *per se,* have simply weakened the body: but with it was combined an increased constructive power; more food could be assimilated, and a more rapid building up of tissues followed the more energetic unbuilding. In a slight degree, the rapid metamorphosis of children was imitated in this increased destruction and increased construction. In other words, the aggressive effect of oxygen on the tissues was heightened either by the larger supply of air which the constant and free movement of the sea air ensures, or by a special quality of the air at the sea-side (excess of ozone?).

The figures on which Beneke relied to prove his case are given farther on, under the head of "Sea Baths." They have been sharply criticised by Prof. Radiche, of Bonn, who believes that they are not numerous enough to allow a conclusion; and some other adverse arguments have been brought forward by an able reviewer (Dr. Sanderson), in the 'British and Foreign Medico-Chirurgical Review.'[1]

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[1] Die Wirkung des Nord-See Bades. Gött., 1855.

At the same time, these experiments appear to me to carry much weight; and though it would be well that they should be repeated, I cannot but believe future observations will confirm Beneke's chief conclusions.

Although Beneke found the urea, the sulphuric acid, and the free acidity of the urine increased—facts all implying greater oxidation—he discovered that the effect on the phosphoric and the uric acid was different: both were decreased.

The lessening in the phosphoric acid is explained, by Beneke, by an hypothesis which he has urged with great ability, but which has yet obtained little favour. As more fully explained under the head of "Sediments," in the Introduction to the 2d Book, he believes that the earthy phosphates are dissolved by oxalic acid, and appear in greatest abundance in the urine when this acid is most largely formed in the system, and that it is so formed when oxidation is least. Therefore, at the sea-side, where oxidation is so active, the oxalic acid will be all destroyed in the body, and, *pro tanto,* its solvent being lessened, less earthy phosphate will pass out. Another explanation is, however, that the earthy phosphates are lessened at the sea-side, because the increased formative processes retain more of the phosphate of lime, which is believed by some to be especially concerned in nutrition.

Not only the phosphoric, but the uric acid was lessened by sea air, though it was increased by sea-bathing. It is conjectured that the increased oxidation would account for this; but as the decrease of uric acid appears to be the statement which is the least warranted by Beneke's figures, it may be well to attempt no explanation until the fact is certain. Pending further inquiries, we may at present say, that the sea air is an oxidizing agent of great power, and that nitrogenous and sulphur-holding tissues (muscular chiefly?) more rapidly disintegrate under its influence. The excretion of the chloride of sodium was not affected by the sea air.[2]

2. The effect of the inhalation of *chloroform* and *ether* on the normal constituents of the urine is not yet known. Reynoso[3]

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[1] British and Foreign Med.-Chir. Review, Jan., 1856.

[2] Dr. Sanderson, in the Review above referred to, has pointed out a possible effect of sea air of great importance. Its evaporating power is, on an average, at least 20 per cent. less than that of the air of inland places. If then cutaneous and pulmonary evaporation is lessened by sea air, the action of the kidneys may be increased as a compensation.

[3] Comptes rendus de l'Académie, tom. xxxiii, xxxiv. The great fallacies attending the determination of small quantities of sugar in the urine render these experiments very uncertain.

has affirmed that it causes the appearance of sugar. Beale[1] could not detect any sugar when chloroform was used; Dr. Bence Jones[2] found only a trace after the employment of chloroform for twenty-four hours. Dr. Harley,[3] in some experiments on rabbits with ether and chloroform, could detect no sugar in most cases; but in one experiment, after the animal had been rendered insensible five times in twelve hours, by a mixture of ether and chloroform, there was "a small quantity of sugar."

It would appear that a small quantity of sugar *occasionally* appears after inhalation of chloroform and ether.

3. Iodine, when inhaled, appears in the urine. Its effects on the urinary ingredients are not known.

4. The effect of smoking *tobacco* on the urine has been investigated by Hammond,[4] who found that the amount of urine, of the urea, and of the chlorine, was lessened; the uric, phosphoric, and sulphuric acids, and the free acidity, were increased. The pulmonary carbonic acid was not lessened. Hammond refers the increase of sulphuric and phosphoric acids to increased metamorphosis of the nervous tissues, and the lessening of the urea to diminution in the metamorphosis of the nitrogenous tissues generally. This explanation may perhaps be doubted. The sulphuric acid is only in a small degree the representative of nervous tissue; and, in fact, we generally find its amount tolerably closely corresponding with that of the urea: what should cause a difference in the case of tobacco-smoking, is not clear. Hammond's experiments were continued over periods of ten days; but the other physiological conditions are not fully stated, and, in particular, the amount of food is not given with sufficient care.

5. The effects of other gaseous substances have not been properly examined. Professor Vogel[5] has observed that arseniuretted hydrogen, when inhaled into the lungs, produces a most peculiar condition of the urine, which becomes black from dissolved blood pigment, and highly albuminous. Vogel conjectures that this is owing to rapid destruction of the blood-cells.

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[1] Brit. and For. Med.-Chir. Rev., Jan., 1853, p. 106.

[2] Ibid., p. 109.

[3] Ibid., July, 1857, p. 193.

[4] American Journal of Medical Science, Oct., 1856.

[5] Eine eigenthumliche Veränderung des Urins, Archiv des Vereins, Band i, p. 209. The same effect is produced on dogs.

SECTION II.

APPLICATIONS TO THE SKIN.

1. *Baths.*

During the last five or six years, several most elaborate investigations on the action of baths of various kinds have been undertaken by L. Lehmann, Beneke, and others. The great difficulties and the many sources of error which attend these inquiries have prevented the results from being commensurate with the labour which has been given to the subject; but yet it is evident that the methods employed are correct, and, in the later investigations of Beneke and Lehmann, care has been taken to obviate all possible fallacies. Considering the great use made of baths in medicine, and the beneficial effects which undoubtedly follow their use, there is perhaps no subject in the whole range of therapeutics which is more interesting to the physician than that of their action on the heart, on the nervous and digestive system, and on the eliminating organs.[1]

Baths may be supposed to act differently, according to the time the bath is used, to the amount of surface covered by the water, to the temperature of the water, and to the substances dissolved in it. Each kind of baths requires a separate investigation.

Baths of Simple Water.

(*a*) *Cold Hip* (*Sitz*) *Baths.*—L. Lehmann has particularly examined this point.[2] He believed, at one time, that he had succeeded in showing that, from the use of fifteen or thirty minutes' cold sitz bath during fasting hours, there was an increased elimination from the skin, kidneys, and bowels, and necessarily a greater loss of weight of the body than in an equal time without the baths. An examination of his experiments, however,[3] has shown, that as the observations were made at widely separated periods, they are not comparable; and that, in addition, the differences between the bathing and non-bathing days are not beyond the normal limits of variation. To quote, however, his results. As far as the urine was concerned, Lehmann found the augmented flow to be due partly to water (one half), partly to solids (one half). Of the solids, the increase was owing chiefly to urea (three fourths); the rest, to chloride of sodium. The sulphuric acid was unchanged; the phosphoric, if anything, lessened; the uric acid altered only within the obvious limits of error.

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[1] As the limits do not permit more than a summary of the subject, I beg to refer to a review, by the author, in the British and Foreign Medico-Chirurgical Review, Jan., 1859, on the "Influence of Baths on the Excretions," for a fuller criticism of experiments than can be given here.

[2] Archiv des Vereins für wissench. Heilk., Band i, p. 521.

[3] See the Review above referred to, p. 137.

Böcker[1] and Lampe have also examined the effect of the cold sitz bath, and they entirely deny that any effect, beyond the limits of natural variation, is produced on the water, urea, chlorine, sulphuric acid, phosphoric acid, or phosphate of lime. The baths were used for twenty-one minutes.

Dr. L. Lehmann has replied to this paper of Böcker's, and asserts that Böcker's own figures prove that there was in his experiments an increased loss of weight over the non-bath periods. At any rate, it must be said that the influence of cold sitz baths on the urine is not very marked.

(*b*) *Warm Hip Baths.*—Dr. L. Lehmann[2] has also examined this point, though in a manner somewhat different to that employed in the former series. The urine was determined every hour during fasting, until its composition was stable. A warm sitz bath was then used for fifteen minutes, and the subsequent variations in the urine were put down to this agent, as no other physiological cause of alteration was in action.

When the baths had a temperature of 15° Reau. (65°·75 Fah.) or 25°—31° Reau. (88° to 99°·5 Fah.), the water of the urine always augmented, and this to an extent (30 to 150 c.c. per hour) and with a constancy which at first really seems to preclude error. But as the experiments were not very numerous, and as the remarkable fact was noticed, that baths of a temperature of 17°—25° Reau. (70°—88° Fah.) did not have this effect, it is impossible not still to feel a little doubt. Lehmann endeavours to explain the exceptional effect of baths between 70° and 88°, by supposing that decidedly cold or decidedly hot baths irritate the cutaneous nerves, and thus act on the kidneys (relaxation of vessels?); but that baths of medium temperature do not have this effect.

The urea, the uric acid, the chloride of sodium, and the fireproof salts, were also supposed to be augmented by the baths of cold and hot, but not by those of warm water (70° to 88°).

The fasting body lost weight more rapidly with, than without, the baths.

The excretion from the skin and lungs is said by Lehmann to be increased, but it does not appear to be so from the figures he gives.

It may be said, finally, that, as in the former series, these experiments must be considered as merely preparing the ground for more accurate inquiries.

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[1] Moleschott's Untersuchungen, Band vi, p. 51 (1859).

[2] Archiv des Vereins, Band ii, p. 1.

(*c*) *General Warm Baths.*—Dr. L. Lehmann has, since his experiments on hip baths, investigated on a larger scale, and with much greater precaution, the subject of the influence of general warm baths.[1] The last and most complete series of experiments comprised the examination of the excreta during ten days without, and ten with, baths; all the ingesta and egesta were measured and weighed, and the external thermometrical and barometrical conditions were noted.

The water of the urine was found to be always and greatly augmented, *for the time*, by the bath (duration, one hour; temp. 78° Fah.)—nearly fourfold (from 1 to 3·9), but subsequently the amount lessened; so that the urinary water of twenty-four hours *was not increased*. In other words, the general warm bath is a temporary eliminator of water. Lehmann's experiments seem to me to establish this point, and they are also confirmed by those of Nasse[2] and Poulet. Falck has, however, affirmed the contrary.[3]

The solids of the urine are also probably augmented; and Lehmann at one time believed he had satisfactorily demonstrated an increase in the amount of urea. But he now doubts whether the experiments were numerous enough to do more than enable him to affirm the *probability* of this occurrence.[4] The alteration in the other constituents must be left undecided.

The acid reaction of the urine is lessened after all but very hot baths, according to Homolle.[5]

The insensible perspiration (skin and lungs) is often increased; and, apparently, this rather depends on the temperature. Mosler,[6] from the use of very hot baths, has shown that baths of 104°—111° Fah. increased the skin and lung excretions enormously; the urine was not augmented; 1 to 1½ lbs. of body-weight were lost in an hour. Yet this is afterwards compensated in some cases; for Lehmann found his weight increase under the use of the warm bath, which it could not have done under the same diet if the excretions, on the whole, had not been lessened. The weakness produced in many persons by the warm bath may be due to continued over-excretion; and there may be individual differences, whether the skin or kidneys are most affected.

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[1] Die Sooltherme zu Bad Oeynhausen (Rehme) und das gewöhnlich Wasser, Gött., 1856. Archiv des Vereins, 1858, Band iv, p. 18.

[2] Einige Beobachtungen über die Wirkung warmer Bäder auf die Harnabsond, Archiv des Vereins, Band ii, p. 265.

[3] Archiv für phys. Heilk., 1852, p. 771. The experiments of Falck are very good; the urine was determined every hour. Four series of experiments are recorded; in two there was no increase, but in the other two there certainly was a slight rise, though Falck regards it as immaterial. The temperature of the baths was 88°—95° Fah.

[4] Archiv des Vereins, Band iv, p. 30.

[5] L'Union Médicale, 1853.

[6] Virchow's Archiv, Band xiv, p. 565.

It is an interesting point to inquire how that which may be termed the one certain fact, viz., the temporary increase of the water by warm baths, is brought about. The most obvious explanation is, that there is absorption of water by the skin. It is impossible here to go into the evidence on this physiological point,[1] but the latest experiments are, on the whole, opposed to such a solution, and at least show that the absorption is trifling; while the fact that the increase of urine is followed by diminution below the normal amount, does not accord with this explanation.

Another solution is based upon some supposed irritation of, or influence exerted on, the cutaneous nerves, which reacts on the kidneys; producing relaxation of vessels, and lessening the tension with which the vessels act against the lateral pressure of the blood. This hypothesis has no direct proof, but is based simply on the negation of other explanations, and on the well-known fact of the alterations in certain vessels which are produced by hot and cold applications to distant parts.

The other point which seems pretty certain, viz., the lessening of the acidity, is yet unexplained.

(*d*) *General Cold Baths.*—The cold bath has very much the same effect as the hot; the urinary water is temporarily increased, and the urea and chloride of sodium are probably also augmented. The "insensible perspiration" is said to be lessened, but on this point more evidence is required.

(*e*) *Medicated Water Baths.*—The experiments on this point are very incomplete. The curative action of many agents is very striking; the hydrochloric and nitro-hydrochloric baths, for example, are known to have a most useful influence on torpid skin,[2] and Kletzinsky has lately pointed out that no stimulating application to the skin is more powerful than these acids. Chloride of sodium and sulphuret of potassium baths also greatly stimulate the skin, and no doubt act directly or indirectly on the urine, and it is much to be wished that systematic experiments should be made with these substances.

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[1] For the later writers see especially L. Lehmann, in Archiv des Vereins, Band ii, p. 21, who denies absorption. Poulet, L'Union Méd., 1856, No. 33, who also denies absorption. Vierordt, in the Archiv für phys. Heilk., 1856, p. 575, who admits absorption. Duriau, Archiv Gen. de Med., Fév., 1856, who believes it occurs in some circumstances, but not in others, viz., when the temperature is below the temperature of the body.

[2] For additional evidence on this point, see Sir Ranald Martin's late admirable work, on the Influence of Tropical Climates (Appendix).

It would appear, however, that few, if any, substances are directly absorbed from the bath;[1] so that any alteration in metamorphosis of tissue, and in the excretions, must be produced indirectly though the action on the cutaneous nerves and on the cutaneous excretion.

Name of substance used in bath.	Discovery or not of ingredients or substances, derived from the bath, in the urine.	Observer.
Iodide of potassium ...	not	Homolle[2] Kletzinsky[3] Braune[4]
Iodine	„	Duriau[5] Braune[4]
Ferrocyanide of potassium	„	Homolle[2] Kletzinsky[3] Duriau[4]
Carbonate of potash ...	Potash increased	Homolle[2]
Alum	not	Duriau[5] „ [4]
Chloride of sodium ...	„[6]	Homolle[2]
Nitrate of potash ...	„	Duriau[5] „ [5]
Sulphate of magnesia ...	„	Kletzinsky[3] Duriau[5]
Sulphuret of potassium...	„	Kletzinsky[3]
Borax	„	„ [3] Duriau
Acetate of lead	„	„
Nitric acid	„	„
Sulphate of quinine ...	„	Duriau[5]
Infusion of digitalis ...	„	„
„ belladonna ...	„	„

As already said, the effects on the urinary excretion of baths of these substances is unknown. Nasse has stated that a bath of carbonate of potash increases the urinary water to double; but as the same effect is produced by simple water, it is uncertain whether the carbonate of potash has anything to do with this.

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[1] The passage of substances, especially of colouring and odorous matters, has been often asserted; but if no friction be used, it is at least very doubtful. Writers, in general, seem to have been too ready to admit the passage of saline substances through the human skin.

[2] L'Union Médicale, 1853.

[3] Canstatt's Jahresb. for 1853. Loschner's Report on Mineral Waters, p. 96.

[4] Archiv für path. Anat., Band xi, p. 295.

[5] Archiv Gen., 1856, t. i, p. 161.

[6] The chlorides of the urine were even lessened after a bath (Homolle), probably from the great cutaneous action.

It is very curious, however, to find that almost all baths, whether the ingredient be acid or alkaline, *lessen the acidity of the urine.*

Bath used.	Effect on acidity.	Authority.
Chloride of sodium ...	Lessened	Homolle Duriau[1]
Iodide of potassium ...	”	Homolle Duriau
Carbonate of soda ...	”	”
„ potash ...	”	”
Ferrocyanide of potassium	”	” ” Homolle
Nitre	”	Duriau
Alum	”	”
Sulphate of magnesia ...	”	”
Sulphate of quinine ...	”	”
Infusion of belladonna ...	”	”
Nitric acid	”	”

The lessening amounted often to complete alkalinity; and this was the case even with the nitric-acid bath.

The same effect, as presently to be noticed, is produced by many, although not by all, natural saline baths.

(*f*) *Natural Saline Baths.*—Although the use of the natural saline baths in medicine has been common since time immemorial, it is singular how little is positively known of their action on the excretions. Much has been written, and little has been discovered. The only works which, even now, deal with this subject in a good method are those by Dr. L. Lehmann, Beneke, and Neubauer. The difficulties in the inquiry are enormous, as there are often many ingredients, gaseous and otherwise, held in solution at different temperatures in different quantities.

1. *The Vichy Waters* (chiefly bicarbonate of soda).—Durand Fardel has particularly directed attention to the very rapid

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[1] The amount of the substances used in Duriau's experiments was usually from 200 to 230 grammes; the amount of chloride of sodium was much greater. The time occupied by the bath was about two hours. Absolute alkalinity was often produced.

alkalinization of the urine. In some cases the urine is rendered alkaline in twenty minutes (Chevallier), in other cases not for ninety minutes. This was supposed to arise from direct absorption of the bicarbonate of soda; but as many other baths and medicated waters have the same effect, the absorption cannot be considered to be proved by this circumstance alone.

The amount of urine is not increased (Petit[1]); the perspiration is alkaline; the alvine discharges are lessened (Petit).

2. The baths of Plombières (alkaline) and of Ems (alkaline) have been found by Mussat[2] and Spengler[3] to lessen the acidity of the urine, and the former water often produces complete alkalinity.

3. The action of the baths of Wiesbaden (chloride of sodium chiefly) has been examined by Neubauer[4] on himself and Dr. Genth. On himself (mean of successive eight days,) these baths were strongly eliminative; half-an-hour bath (temp. 28° Reau. = 95° Fah.) increased considerably the water (294 c.c.), the urea (6·570 grammes in twenty-four hours), the uric acid, and in a less degree the SO_3 and PO_5, the chlorine, lime, magnesia, and ammoniacal compounds. The free acidity was increased; and in this these baths differ greatly from so many others. Simultaneously drinking the water augmented these effects, and the urea augmented by as much as 9·086 grammes per diem over the ante-bath period. In the case of Dr. Genth, the effect was quite different; the bathing *diminished the urea and the sulphuric acid,* and augmented only very slightly the water, the uric acid, the phosphoric acid, and the ammonia; the chlorine was rather more increased. When the waters were drunk, as well as used externally, not only were the urea and the sulphuric acid diminished, but the uric acid was also lessened; the decrease in the urea was, however, less than when baths alone were used.

The urinary water was increased considerably by the bath in Neubauer (from 1414 c.c. to 1707 c.c. in twenty-four hours), but in a less degree in Genth (from 1252 to 1305). Drinking the water increased it, of course, in both; but in Genth's case, the increase was not commensurate with the amount of fluid drunk.

The inner use of the water, with coincident exercise, increased, in Neubauer's case, the excretion of the lungs and skin considerably.

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[1] Du mode d'action des Eaux Minérales de Vichy. Paris, 1850.

[2] L'Union Méd., 1853, No. 34. Drinking the water had not the same effect.

[3] Deutsche Klinik, 1854, No. 22.

[4] Archiv des Vereins für wiss. Heilk., Band iii, p. 59. See also Braun (Des Eaux Minérales de Wiesbaden, part ii, p. 18), who has made a few experiments; so few, however, as to give quite uncertain results. He believes that the quantity of urine and the amount of chloride of sodium were augmented. The continued use of the bath stimulates the skin, and cutaneous eruptions are common.

The differences between these two series of experiments show, either that the experiments were not nearly numerous enough, or that individual peculiarities of constitution modify the effect of the baths to a considerable extent; at present the discrepancy is remarkable.

4. The effect of the saline bath (sooltherme—chloride of sodium chiefly) of Oeynhausen, on himself and one other person, has been investigated with great care by L. Lehmann,[1] and the results are compared with the effect of simple water baths on the same persons. The general conclusion accords rather with the experiments made on Genth with the Wiesbaden water, than with those on Neubauer.

When a single saline bath was taken, and the immediate effect observed, the urinary water and solids were increased, but in a much less degree than with pure water baths; but when the saline baths were continued for several days regularly, a different result was obtained, and the effect of the saline was quite opposed to that of the simple water bath. Thus, the average daily amount of *ingesta* (food, drink, &c.) during the non-bathing period was 2038 grammes, and during the bathing period 2079 grammes; the *excreta* averaged daily, during the same periods, 2147 and 2072 grammes; *i.e.*, during the non-bathing period, there was daily loss of weight from disproportionate excretion (the cause of which is not apparent), *which was arrested by the bath.* There was, therefore, a more energetic assimilation, and a less rapid disintegration, during the bathing period. The lessened excretion produced by the bath was found to be attributable to lessened urine; for the insensible perspiration (skin and lungs) was increased nearly 12 per cent., and the intestinal excretion was increased from 149 grammes to 195 grammes daily. The water of the urine was lessened, on the contrary, by 162 grammes (5 ounces) daily, and the urinary solids by nearly 3 grammes (46⅓ grains).

The individual lessening was as follows:

Daily excretion of Urinary Solids.

	Before the bath period.	During the bath period.
Urea	33·5 grammes	33·0 grammes.
Fireproof salts	26·2 ,,	19·8 ,,
ClNa	5·6 ,,	4·2 ,,
SO_3	2·6 ,,	2·3 ,,
PO_5	1·9 ,,	1·8 ,,
Uric acid	0·69 ,,	0·63 ,,

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[1] Die Sooltherme zu Bad. Œynhausen, 1856, and Archiv des Vereins für wissench. Heilk., Band iii, p. 1; and Band iv, p. 18.

The free acidity was little affected; if anything, increased.

One remarkable fact was, that while the alkaline phosphates were increased, the phosphate of lime was very considerably lessened; and Lehmann is inclined to connect this with the increased tissue-building produced by the bath, and with which it is now presumed the phosphate of lime is especially connected. After the baths were left off, the urinary solids, and especially the urea, increased above the average even of the ante-bath period. This did not depend on lessening of the cutaneous excretion; for this remained still somewhat increased. Its explanation is not easy.

The general conclusions from Lehmann's experiments on this bath are, that it always exerts a marked diaphoretic action; that its action on the kidneys is uncertain and variable, but that during the height of the diaphoresis the urine excretion is lessened. It increases the intestinal excretion, as a usual rule. The bath, in thus altering the balance between the excreta, seems to exert a tonic influence on assimilation; tissue-building augments, disintegration by the urine lessens, and, an equal quantity of food being taken, the body gains weight.

5. The action of the bath of Nauheim (large amount of chloride of sodium, much bicarbonate of lime and chloride of calcium, much free carbonic acid, and many other minor ingredients) has been investigated with the greatest care by Beneke.[1] The work is a model of such investigations, and is full of experiments and reasonings upon them, which it would be hopeless to attempt to give in detail here. The experiments were conducted on three healthy young men, and every circumstance of diet, weight, exercise, external temperature, &c., was taken into account. Six days experiments were carried on without the bath, and compared with six days with the bath. The weight of the patients was constantly determined, both before, during, and after the baths; all the ingesta and senble egesta were weighed, and the urine was carefully analysed.

The general results are these:—When a bath of a temperature of 25° Reau. (88° Fah.) was used in the morning hours, for half an hour, there was, for some hours, a slightly increased metamorphosis and elimination over the days when no bath was used. This was, however, subsequently partly compensated for by lessened elimination in the afternoon. These effects were different in intensity in different persons.

When the period of twenty-four hours was taken, it appeared that the augmented excretion was owing to the skin and lungs, in the three persons experimented on, but in different degrees; the urine of the twenty-four hours was augmented in one, in whom the activity of the skin was least, and was lessened in two, in whom the activity of the skin was greatest. So that, according to individual peculiarity, the increased elimination caused by the bath occurred either from the skin entirely, or from the kidneys and skin combined.

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[1] Ueber Nauheim's Sooltbermen. Von Dr. F. W. Beneke. Marburg, 1859, pp. 286, with an appendix.

On more particularly examining the periods of increase, it was found that, immediately after the bath, the activity of the skin was least; it increased some hours afterwards; while, on the contrary, the activity of the kidneys was greater during and immediately after the bath, and decreased greatly a few hours subsequently, to such an extent, indeed, as to lead, as already said, to a lessening of the total excretion of twenty-four hours in two persons out of three. This lessening concerned the urinary water chiefly.

In the twenty-four hours' urine the urea was very slightly increased, the amount falling within the limits of variation. The uric acid was lessened in two persons, increased in one, but its variations were unimportant. The phosphoric acid was lessened in all slightly; the sulphuric acid lessened in one, slightly increased in two; the chlorine was increased insignificantly in all—so slightly as to lead Beneke to deny positively any absorption by the skin.

It is clear, from these figures, that the effect of the Nauheim bath on the solids of the urine of twenty-four hours is really inappreciable, although Beneke is disposed to attribute much importance to the lessening of the phosphoric acid, and believes that the variations in the urea is sufficient to prove a slight increase.[1] The chief action of the bath may be said to have been moderately diaphoretic.

In order to try the effect of a greater irritation of the skin, Beneke employed the bath mixed with the concentrated mother-liquor remaining after the chloride of sodium has crystallized out. The liquor contains comparatively little chloride of sodium, but an enormous amount of chloride of calcium (2302 grains per pound) and a considerable quantity of chlorides of potassium and magnesium. *A priori*, it might be anticipated that the diaphoretic action of this strong saline bath would be much greater than that of the natural water.

The effect of the bath (at 25 Reau.) was different from that of the natural bath. In twenty-four hours there was decided increase of the water of the urine, and some increase in the urea, and slight increase of the SO_3 and PO_5. The uric acid and the chlorine were slightly lessened. These effects were most marked in the hours immediately after the bath; some hours afterwards there was a diminution, though not quite enough to compensate for the previous increase.

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[1] The other effects produced by the bath were a lessening of the frequency both of the pulse and of the respirations.

Although we may admit this increased urinary elimination, it was really inconsiderable, except as far as the water was concerned; and Beneke remarks (p. 124), that the good effects of the bath in disease cannot be ascribed to the influence on the urine.

There was no absorption of any of the bath constituents through the skin.

It was remarkable, however, that the skin and lung excretion, instead of being increased by this strongly saline bath, as would have been anticipated, *was actually lessened.* In other words, in three persons, the action of this bath was not at all diaphoretic, but entirely diuretic. In this it differed from the simple bath, and still more from the Oeynhausen bath, the action of which on the skin was very great.

This point is so important, that I give Beneke's own table (p. 116).

There were excreted in grammes—

1. On the normal days,

	Through the skin and lungs.			Through the kidneys.		
	7—1 o'clock.	1—7 o'clock.	7—7 o'clock.	7—1 o'clock.	1—7 o'clock.	7—7 o'clock.
B. ...	347·2	424·6	504·3	305·1	433·0	554·5
Mm. ...	391·5	577·7	518·9	444·8	353·9	384·5
Ma. ...	288·7	455·9	555·7	467·1	429·0	647·2

2. On the mother-liquor bath days (bath in the morning for half an hour),

B. ...	291·0	349·9	537·5	459·5	420·0	595·4
Mm. ...	326·3	339·2	495·3	676·3	394·5	602·6
Ma. ...	276·3	358·5	651·5	676·6	446·3	732·5

Difference.

B. ...	− 56·2	− 74·7	+33·2	+154·4	−13·0	+ 40·9
Mm. ...	− 65·2	−238·5	−23·6	+231·5	+40·6	+218·1
Ma. ...	− 12·4	− 97·4	+95·8	+209·5	+17·3	+ 85·3

Nothing can show more clearly the difficulties of these inquiries than such discrepancies between the action of baths so nearly allied in chemical constitution as those of Oeynhausen and of Nauheim; but the evidence in the above table, founded on six days' experiments in each series, seems conclusive. The intestinal discharges were not increased, either by the simple or the mother liquor-bath.[1]

6. Baths of Sea Water.—Beneke[2] has examined the effect of sea-bathing at Wangeroge, in the North Sea, on his own body. The experiments were conducted by keeping all the conditions influencing metamorphosis as equable as possible; the fluid drunk was measured, the amount of exercise and sleep noted. The immediate effect of the bath on the urine passed soon after it, and the remote effect of the bath on the whole urine of twenty-four hours were determined, in order to fix the period of action of the bath, and also to see if, after its immediate effect had passed off, there was any condition of metamorphosis which was opposite or counter to that produced immediately by the bath.

The effect of sea baths are different, in many respects, from those of sea air. The baths were taken on seven days; the duration was from five to ten minutes; the temperature averaged 69°·76 Fah. The following table, partly taken from Beneke's work, and partly from Dr. Sanderson's review of it, gives the mean of the principal sets of experiments.

Urinary Excretion, in grammes.

	Weight of the body in kilogrammes.	In 24 hours.					1 kilogramme excreted in 24 hours.				
		Urea.	Uric acid.	SO_3.	PO_5.	Cl.	Urea.	Uric acid.	SO_3.	PO_5.	Cl.
In Oldenburg, the place of ordinary residence (inland) .	60·22	24·4	0·41	1·40	2·89	10·2	0·403	0·0069	0·0230	0·0460	0·1668
In Wangeroge (marine), no bath; effect of sea air . .	61·11	27·5	0·21	1·68	2·37	10·5	0·450	0·0035	0·0270	0·0390	0·1734
In Wangeroge—sea bath and sea air	61·25	28·3	0·30	1·89	2·61	9·3	0·462	0·0050	0·0309	0·0427	0·1523

A glance at this table shows that, while the weight of the body increased, the amount of urea and sulphuric acid also augmented with the sea air, and still more with the sea air and bath combined. But are these numbers beyond the limits of normal variation; and are means of seven or eight days sufficient to give the true amount? The increase in the urea was 16·6 per cent.; in the sulphuric acid, it was 35 per cent. These amounts are too great, one would think, to fall within the limits of mean variation.

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[1] The internal use of the water was, in subsequent experiments, combined with, the bath. For these experiments, see "Mineral Water."

[2] Ueber die Wirkung des Nord-See Bades, von Dr. F. W. Beneke. Göttingen, 1855.

Professor Radiche, of Bonn, has, however, asserted, from a mathematical consideration of the amounts of variation, that the increase given in the above table is really within the limits of normal variation; and he refuses any weight to Beneke's conclusions. Dr. Sanderson also doubts whether the figures prove the case. The same critic has pointed out the fact, that the increase in the urea and the sulphuric acid occurred, not immediately after the bath, but some hours afterwards; but this observation does not appear to me to negative the inference that the increase was owing to the bath.

On the bath days, the water of the urine was lessened, probably from the fact that the cutaneous and pulmonary excretions were augmented; the intestinal discharges were also large, and some water may have escaped in this way. The chloride of sodium in the urine was lessened by the bath, in all probability from the increased action of the skin.

I think we may admit that the excretory processes of the body, taken as a whole, were greatly augmented by the sea-bathing. The sea bath acted altogether more powerfully on the tissue metamorphosis than the simple water bath, but, while it did so, it heightened also, and in a still greater degree, the formative processes. The appetite improved; more food was taken, and the body gained weight.

Like the sea air, sea-bathing appears therefore to be a tonic of extraordinary power; its diaphoretic action is much greater than that of general simple water baths, and it would appear probable that its strengthening effect in the formative processes is also greater, though, as its effects have not yet been examined apart from the influence of sea air, this is not quite certain.

Beneke noticed that, after leaving the sea-side, the urea and sulphuric acid went down to their normal inland excretion; while, on the contrary, the uric and phosphoric acids, which had been lowered by the sea air, remained comparatively very much lessened for some time.

It is impossible, in the present state of the inquiry, to arrive at a general conclusion which shall express with any precision the effects of simple, saline, spring, and sea baths.

The cold simple water baths and the sea baths seem to agree in their disintegrating effect on tissues; the former acting especially on the kidneys, the latter on the kidneys, skin, and intestines. In both cases, if the food be kept at the same point, the body loses weight; but it is undoubted that, with this increased disintegration, an augmented assimilating power is often combined; the appetite increases, and if sufficient food be allowed, the increased excretion is more than counterbalanced by the heightened construction, and the body gains weight. This is especially the case with the sea baths.

The effect of the natural saline baths is to act, sometime greatly, sometimes slightly or not at all, on the skin, and in a variable degree on the kidneys and bowels. It is certain that, while urinary excretion is occasionally augmented, the increased action of the skin is in other cases combined with so great lessening of the urine, that, in spite of the food remaining the same, the body gains weight. There must be, therefore, in such cases, lessened disintegration of the substances giving rise to urinary constituents, while, on the other hand, by the mother-liquor bath of Naüheim the urinary constituents are increased.

It may be a question why the sea-bathing should be so different in its action from the saline spring bathing. Possibly, the influence of the sea air, itself an agent of extraordinary power in increasing disintegration, may account for this. But as these experiments have at present been made only on single individuals, it is better to wait for more facts before debating the point.

If the facts noted by Neubauer and Dr. L. Lehmann may be applied generally to saline baths, a therapeutical rule of value is at once obvious. It is this; the saline baths will be useful in cases of debility, combined with imperfect constructive power, from whatever cause, but without lessening of excretion; while the pure water and sea bathing are suitable for cases in which, prior to increased assimilation, augmented disintegration is desired. For example, as remarked by L. Lehmann, cases of anæmia, nervous exhaustion from loss of blood, great mental toil, or sexual excesses, are adapted for the saline baths, while congestions of organs, gout, rheumatism, &c., are fit cases for the more active disintegrating treatment by cold, simple, and sea baths.

7. *Saline Vapour-baths.*—At present so few experiments have been made either with the hot air or the water-vapour baths, that no conclusions can be come to. Dr. L. Lehmann[1] has, however, made some observations on the effect of the watery vapour of the Oeynhausen (saline) vapour-bath, which is impregnated with saline matters. The effect was essentially diaphoretic, especially when the patient used cold washing afterwards (increase of 8 and 14 per cent., without and with subsequent cold washing). The metamorphosis of tissue, as shown by the urine, was little altered. The chloride of sodium

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[1] Archiv des Vereins für wiss. Heilk., 1857, Band iii, p. 279.

and the earthy phosphate in the urine were augmented, which Lehmann ascribes to absorption through the lungs.

8. *Application of the cold Wet Sheet.*—Wundt[1] has carefully investigated the effect of the cold wet sheet on two women, who were treated for slight hysteria in the medical clinic of Hasse at Heidelberg. In two series of experiments the wet sheet was applied for four hours. The body was found to lose weight considerably faster with the sheet than in the corresponding period without it; that is to say, there was an increase of the egesta amounting to almost double in the four hours; and this was chiefly caused by the augmentation of the water, the urea, and the chloride of sodium of the urine. The cutaneous exhalation, sometimes slightly increased, was diminished in other cases, and Wundt believes that water was absorbed through the skin.

When the application of the sheet was continued for six hours, the urinary water, the urea, and the chloride of sodium were proportionably less increased; in fact, it was doubtful whether the urea was increased at all. Wundt believes that there was reabsorption from the bladder after secretion of the urine, during the latter part of this period, and these observations confirm those of Kaupp before referred to. The effect of the hydro-therapeutic treatment would therefore seem to be less, the longer it lasts.

In these cases the effect of this treatment was disintegratory and eliminative by the urine, but very little by the skin. The effect on the skin seems to have been less marked than previous statements of the effect of the wet sheet would have led us to anticipate. I subjoin a table showing the mean results of all the experiments.

In each hour there were excreted in grammes—

When no sheet was used:

Date.	Urine.	Urea.	ClNa.	Insensible Perspiration.	Entire excretion.
12th.	58	1·62	0·57	115	173
13th.	37	1·15	0·30	143	180
15th.	51	1·21	0·43	159	210

Sheet for four hours:

12th.	175	2·05	1·05	— 33	218
14th.	216	2·00	0·95	+ 56	209
16th.	312	2·21	1·55	+100	212

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[1] Archiv für wiss. Heilk., Band iii, p. 35.

Sheet for six hours :

Date.	Urine.	Urea.	ClNa.	Insensible Perspiration.	Entire excretion.
21st.	77	1·03	0·55	—105	192
24th.	104	1·36	0·58	— 72	176

The difference between the four and the six hours wet sheet is well seen.

Böcker[1] has also investigated the effect of the wet sheet used for two and two and a half hours. The body here also lost weight faster than without the sheet, but this seemed to be on account of increased perspiration, and not from diuresis, for though it could not be certain that the water of the urine, the urea, the chloride of sodium, and the sulphuric acid were not increased, Böcker could not satisfy himself that the increase was beyond the limits of variation. The phosphates of soda and potash were lessened. The fæces were not increased. Here the reverse of what was noted in Wundt's cases occurred; the skin was acted on in a great degree, the kidneys to a much less extent, or not at all.

The effect of the wet sheet seems to be very similar to that of baths, though whether it possesses any advantage over these is not clear. In some cases the skin is acted on, in other cases the urine, and in any special case the direction of the action of the sheet will depend on individual peculiarity.

2. *Friction and Anointings.*

Although, in simple bathing, substances are not, or are very slowly, absorbed by the skin, it is different when friction is employed.

It need not be said that mercury, antimony, &c., are absorbed in this way, and that turpentine gives its odour to the urine.

Poulet could detect no antimony or belladonna in the urine, when these substances were rubbed in on the unabraded skin.

Tar, when rubbed in, has been found by Petters[2] and Weber[3] to give a dark colour and tar odour to the urine, and to cause the deposition of all the uric acid in the urine, so that no more could be afterwards precipitated by hydrochloric acid. This deposit was caused by the presence of the carbolic acid of the tar, which had been absorbed, and had taken soda from uric acid. Another acid, homologous with carbolic, but with higher boiling point, was also present.

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[1] Moleschott's Untersuchungen, Band vi, p. 51 (1859).

[2] Prag Vierteljahesch., 1855, No. 3.

[3] Hermann Weber (quoted by Hughes in Guy's Hospital Reports, 1856, p. 52) noticed, some years ago, the dark colour. Tar taken internally may have the same effect.

Fomentations of digitalis increase the flow of urine (Christison); the effect on the solids has not been investigated.

3. *Blisters.*

The absorption of cantharides is extremely probable, as it can scarcely be supposed that the strangury occasionally produced by blisters has any other cause. After the use of blisters, albumen occasionally appears in the urine, especially in cases of strangury (Christison).[1] The frequency with which this occurs is not known. Bouillaud mentions that, in fifteen cases in which blisters were applied to previously scarified parts, albumen appeared in the urine in all but one case. The albuminuria lasted usually from one to three days; in one case, for a month. It has been pointed out, however,[2] that most of these examples were in persons who had pneumonia, or who were just recovering from it; and the frequency of albuminous urine in pneumonia is well known, and may have accounted for some of the cases. In more than one hundred cases in which blisters were applied to the unabraded surface, Abeille[3] could find no albuminuria.

SECTION III.

INJECTIONS INTO THE INTESTINES.

The influence of cold clysters on the quantity of the urine has been studied by Falck.[4] He selected fasting hours, determined the urinary flow for two hours, injected cold clysters, and measured the urine hourly for five succeeding hours. The following table gives the results:

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[1] Monthly Journal, Jan., 1851.

[2] Archives Gen. de Médecine, 1848, 4th série, tome xvii, p. 99.

[3] Abeille, Gazette des Hôpitaux, année xxiii, tome ii, No. 7136.

[4] Vierordt's Archiv für phys. Heilk., 1852, Band xi.

	First experiment.	Second experiment.	Third experiment.	Fourth experiment.
	c.c.	c.c.	c.c.	c.c.
Urine from 7 to 8 o'clock, a.m.	36·7	48·9	46·2	19·2
„ 8 „ 9 „ „	30·2	29·5	38·2	28·4
Clysters of water at 9 o'clock	500·0	660·0	660·0	666·0
Urine from 9 to 10 a.m. .	46·7	50·1	32·5	38·4
„ 10 „ 11 „ .	169·0	262·2	158·6	201·7
„ 11 „ 12 „ .	56·2	220·2	49·8	67·6
„ 12 „ 1 „ .	117·2	97·4	36·2	30·4
„ 1 „ 2 „ .	97·1	49·6	38·6	33·5

It will be observed, that the increase of urine caused by the clysters did not occur till the second hour after the injection, and lasted for one, two, or three hours; from a fourth to a half of the water of the clysters passed off with the urine.

The effect on the solids has not yet been traced out; probably, it is similar to that of water taken into the stomach.

Many medicinal substances injected into the intestines are absorbed very readily, and appear in the urine.

SECTION IV.

SUBSTANCES TAKEN BY THE MOUTH.

1. *Mineral Waters.*

In the previous section on "Baths," the effect of the internal use of the waters of Wiesbaden has been noticed.

Nauheim water.—In his treatise on the Nauheim bath, full details are given, by Beneke, on the effect of drinking the water.[1] Three persons were experimented on, and the very satisfactory experiments are given with great minuteness. We give the conclusions, without entering into much detail.

1. The use of 600 c.c. (20 fluid ounces) of the diluted spring (half spring, half simple water), taken in early morning, and followed by moderate exercise, produced, in the hours of the morning and afternoon, an increase of all the excretions from the kidneys, intestines,[2] skin, and lungs. Subsequently, however, the

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[1] In his very interesting and instructive little treatise, 'On the Nature and Use of Mineral Waters,' Dr. Aldridge speaks of the Nauheim water as not being used internally. It is, however, taken diluted, as in the experiments quoted in the text.

[2] It was not evident, from the darker colour of the fæces, that the excretion of bile colouring-matter was augmented, as has been affirmed.

excretions all lessened; so that the body occasionally actually gained weight for the time, instead of losing it, in the twenty-four hours, though the food remained the same. Eventually, at the end of six days' experiments, one observer had gained 11 grammes, the two others had lost 85 and 37 grammes in weight. On accurately examining, however, what was the cause of this occasional gain of weight, it was found to be dependent, not on increase of solids, but on retention of water occurring in the hours after the great excretion (chiefly the night hours); so that the effect of the bath *was to lessen the total solids of the body, but to increase the water of the body*—and this in a degree sufficient, at some periods, to counterbalance the loss of solids, and even to give weight to the body. To use Beneke's own words, the "body was more highly saturated with water."

The increased metamorphosis in the solids was shown in the urea and sulphuric acid (mean increase, 5 grammes and 0·200 gramme in twenty-four hours), while the phosphoric and uric acids were scarcely altered. As urea was largely increased, and the nitrogenous tissues of the body were therefore lessened in amount, the phosphoric acid must have been in relatively larger proportion in the body after, than before, the use of the waters.

The chlorides taken in the water passed entirely out of the system in the six days during which the experiments were carried on. The chlorides in the urine augmented daily about 7 grammes. Beneke's figures lead to the inference that this mineral water, so rich in chlorides, actually caused the passage from the system of chlorides derived from the body itself (p. 162)! Certainly, a most unexpected result. Nothing is stated with respect to the free acidity of the urine.

Individual differences modified the action of the water, so that, according to the person, either the kidneys, or the lungs and skin, or the intestines were most affected: the following table shows this well.

There were excreted in each twenty-four hours, in grammes—

Mean of six normal days.

	Through lungs and skin.	Through the kidneys.	Through the intestines.	Altogether. Total egesta.	Total ingesta in each 24 hours.
B. . .	1015·9	1811·4	153·6	2980·9	2901·8
Mm. .	1248·0	1717·6	146·5	3112·1	2989·3
Ba. . .	1215·6	1830·4	165·3	3211·3	3086·7

Mean of six mineral-water days (600 c.c. of mineral water added to same food).

	Through lungs and skin.	Through the kidneys.	Through the intestines.	Altogether. Total egesta.	Total ingesta in each 24 hours.
B. . .	1347·3	1977·7	318·8	3643·8	3558·1
Mm. .	1523·5	1861·0	225·0	3609·5	3621·1
Ba. . .	1620·2	1941·7	192·5	3754·4	3717·6

The pulse was little affected by the water; the respirations were invariably lessened in number.

It will be observed that, during the normal days, the excretions in all the persons surpassed the ingesta,—the body lost weight; but during the use of the mineral water, the loss of weight was less in two, and was changed into increase of weight in one, from retention of water.

What was the cause of the action of this spring on the solids of the urine? The temperature of the water, 17°·8 Reau. (72° Fah.), cannot have had much effect, if Mosler's investigations on simple water can be relied on. The water itself may be supposed to have some influence, but its quantity was not great. Was it, then, the mineral ingredients which caused the increased excretion of solids? We have seen that chloride of sodium has little effect; and yet chloride of sodium is the chief ingredient in the Nauheim spring. Are the other salts more efficacious, or do they add to the effect of the chloride? Or is it a conjoint effect of temperature, water, exercise, chloride of sodium, and the other ingredients, such as the bicarbonate of lime, the chloride of calcium, or the free carbonic acid? No answer can be given to this question till each agent has been investigated singly.

Whatever may be the ultimate answer to this inquiry, Beneke's facts seem sufficient to prove that the action of this water is as above described, and that it may be a possible curative agent. The desire for food was not, or very little, increased by its use, as in the case of many mineral waters.[1]

When the bath of Nauheim water was combined with the internal use of the water, it was found that the intestinal

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[1] Each of the three experimenters took, in the twenty-four hours, as much solid food as they liked, restricting themselves to 2400 grammes of fluid. The solids taken were:

	In the normal days.	In the mineral-water days.
B . . .	1101·8 grammes . . .	1158·1 grammes
Mm . . .	1189·3 „ . . .	1221·1 „
Ba . . .	1286·7 „ . . .	1317·6 „

excretions, the skin and lung excretion, and the urine, were all increased; the increase was not always greater than when the mineral water was taken without the bath; when it was greater, as sometimes occurred, this arose from increased kidney excretion. The increased excretion occurred during the day, *i. e.*, in the hours immediately following the use of the agent, while, during the night, there was compensatory lessening of excretion. As in the former case, water was retained in the system, but in less quantity than with the mineral water alone. As in all former experiments, individual peculiarities determined whether the increased elimination affected most the kidneys or the skin and lungs.

The urea and the SO_3 of the urine were increased equally as in the drinking experiments, in two cases; more so in the third case. The phosphoric and uric acids were little altered. All the chloride was not eliminated, but a little was retained in the system; so that here an important difference arises between the internal use of the mineral water *per se*, and with the bath. Did the bath lessen the exit of chloride by the skin?

The pulse was lessened in frequency, as by the bath alone, and the respiration was also lessened.

The desire for food was greater; and more being allowed, the body, in spite of the augmented disintegration and elimination, increased in weight. The chief modification introduced by the bath was a greater diuretic effect.

Vichy waters.—The extensive use of the waters of Vichy, and their acknowledged beneficial effects, would have led, we should have supposed, to a thorough examination of the condition of the urinary ingredients. But this has not yet been properly done. The Vichy waters render the urine alkaline. According to Petit,[1] two glasses (containing 2 grammes of bicarbonate of soda) alkalinize the urine, and this continues for seven hours; three glasses make the urine alkaline for twenty-four hours; and five glasses in twenty-four hours (= 5 grammes, or 77 grains, of bicarbonate), with bathing, keep it permanently alkaline. Probably, however, great individual variations occur. Petit affirms that the perspiration is also alkaline.

The Friedrickshall waters.—Mosler[2] has lately contributed an elaborate paper on this subject. The Friedrickshall waters contain, in 16 ounces, 46½ grains of $NaOSO_3$, 39·5 grains of $MgOSO$, 10 grains of $CaOSO_3$, 61 grains of $NaCl$, 30 grains of $MgCl$, a little carbonate of magnesia, and insignificant quantities of other ingredients. Mosler's researches show the effect of different quantities on the body-weight, the intestinal excretions, and the water, urea, SO_3, NaCl, and uric acid of the urine. The experiments were conducted on two healthy males and one rather unhealthy female, and extend over periods of twenty-seven or thirty-six days, viz., eight or nine days before the use of the water, nine or eighteen during, and nine afterwards. The general results of the first two cases were these:

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[1] Du mode d'action des Eaux Min. de Vichy. Paris, 1851.

[2] Archiv für wiss. Heilk., 1860, Band v, p. 1.

1. The weight of the body was not materially altered.

2. The intestinal excretions were generally augmented, and in some cases, when the amount of water was large, they were greatly so (from a mean of 160 to 190 grammes, in twenty-four hours, to 500 to 646 grammes). Food had an influence on this: if the water was taken before food, the fæces were augmented; if after food, this was not the case, or so in a less degree. It was undetermined whether the augmentation was due to increase in the solids of the fæces, or merely to liquid.

3. If the fæces were not increased, or if the amount of water drunk was very large, the quantity of urine was augmented; and it was so in proportion to the water drunk, and inversely to the amount of intestinal discharge. The urea was decidedly, though slightly, increased when the bowels were not acted upon; and Mosler concludes that "the increase of urea rose and fell in inverse proportion to the action of the water on the intestines."

In this case, indeed, the antagonism of the bowels and kidneys, as regards urea, is clearly brought out, just as we have seen, in other instances, the antagonism of the skin and kidneys. The amount of increase in the urea was not great (about 6 to 8 per cent.).

The chlorine and sulphuric acid were, of course, increased, as so much was introduced with the drink, and comparatively little can have passed off by the stools, even when the action of the water was chiefly on the bowels.

The uric acid, in one series of experiments, was lessened; but the experiment requires repetition.

The pulse, respirations, and temperature were unaltered by the water.

In the third case given by Mosler (a woman, not perfectly well), the water was given in large quantities (1000 grammes per diem); the fæces were augmented from 205 to 1169 grammes (mean of nine days); the quantity of urine was also augmented one third; the urea was not determined. The body-weight, in spite of the diarrhœa, increased, for the appetite improved, and unlimited food was allowed.[1]

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[1] Mosler has also less carefully examined the effect of the water in many diseases. He found it particularly useful in uterine engorgements and in chronic lung affections. It is evidently a powerful eliminative.

The use of the chalybeate mineral waters need not detain us. Nothing is known, except they add iron to the blood, and have a general tonic effect.

The effect of the sulphur waters has, unfortunately, not yet been properly traced out, and it seems undesirable to allude to statements not based on accurate modes of observation.[1]

2. *Metals and their Preparations.*

Antimony emerges in part or altogether by the kidneys; its mode of combination is uncertain, and the rate at which it passes out is also unknown. Two preparations only of antimony have been yet examined.

The effect of *tartar emetic* has been investigated by Böcker,[2] Beigel,[3] and Ackermann.[4]

Böcker took, in nine days, 23·46 grains (= 2·6 grains daily). The appetite was greatly diminished (one third), and this probably accounted for the fact that, with the exception of the water, which was slightly increased, all the urinary constituents were lessened; thus:

The solids were lessened	by	7·169	grammes in each	24 hours.
Urea	„	4·874	„	„
Uric acid	„	0·002	„	„
Fireproof salts	„	0·086	„	„
Volatile salts and extract		2·307	„	„

The only alteration of importance was, therefore, in the urea; and Böcker's experiments leave it undetermined, whether there was actual lessening of metamorphosis, or retention, from the effect on the heart or the nervous system, or whether the impaired digestion would account for the diminution.

The CO_2 of the lungs was found to be increased.

Beigel's experiments were made on two men, who took in each twenty-four hours 2 grains of tartar emetic, during four days. Great nausea was caused, and probably there was loss of appetite, though nothing is said on this point. The urine was sometimes increased, sometimes lessened in quantity; the urea was invariably decreased (by about 5 grammes in each twenty-four hours). Beigel attributes this to the tartar emetic, and not to the want of food; but this opinion may be questioned, and, on the whole, Beigel's experiments do not seem entitled to much weight, as the conditions of the experiments are imperfectly given.

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[1] Considering the very extensive use of mineral waters, and their undoubted utility, it is very surprising that so little has been hitherto done to trace out their effects on the excretions. The observations of Genth, Beneke, and Mosler, however, promise well for the future; and if any one has opportunity to pursue this inquiry, I would strongly recommend him to follow the method Beneke has adopted in his treatise on Nauheim.

[2] Beitrage zur Heilk., 1849, vol. ii, p. 324.

[3] Untersuch. über die Harn. und Harnstoffmengen von H. Beigel (Aus "Nova Acta," &c., besonders abgedruckt). Wien, 1856, p. 49.

[4] Zeitschrift für rat. Med., Band ii, p. 241. See a review by the Author in the Brit. and For. Med.-Chir. Rev., April, 1859.

Ackermann's experiments are quite at issue with the above. From a very careful series of observations, he found that—

1. Tartar emetic augmented the "insensible perspiration" (skin and lungs) greatly (by half, or, other cases doubled, or even more than doubled). This was, no doubt, partly owing to the skin, but perhaps also to augmented pulmonary CO, as Böcker found this to be increased.

2. The stomach and intestinal secretions were increased, and there was often vomiting and purging.

3. The urinary water and the chloride of sodium were lessened, no doubt from an increased passage by the skin and bowels. The urea, however, was greatly augmented, and apparently in accordance with the dose of the medicine; the pigment and uric acid were also, but less constantly and less largely, increased.

It is not yet evident whether the ureal increase was owing to augmented *elimination* or augmented *formation*. Ackermann's analyses are not numerous enough, nor repeated at sufficiently short periods, to prove this. But of the increase there seems no doubt. Tartar emetic is, therefore, an eliminator of urea, even if it does not increase its formation.

The effect of the *golden sulphuret of antimony* has been examined by Böcker.[1] All the constituents of the urine were increased, as shown in the following table, in which the mean results are given:

In each twenty-four hours, in grammes.

Constituents.	With 21 grains of sulph. ant. aurat. daily: mean of 9 days.	Normal excretion.	Increase with the sulphuret.
Water	2709·727	2292·306	417·421
Solids	77·162	67·294	9·868
Urea	27·197	20·913	6·284
Uric acid	0·401	0·344	0·057
Fireproof salts	27·244	24·870	2·374
Soluble salts	24·192	22·298	1·894
Insoluble salts	3·052	2·572	0·480
Sulphuric acid	3·438	1·724	1·714
Volatile salts and extractives ...	22·320	21·167	1·152

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[1] Beiträge zur Heilkunde, vol. ii, p. 93.

The chief objection to the experiments is, that it may be questioned whether the amount attributed to the normal excretion is correct, and affords a safe standard of comparison with the excretion under antimony. This increased elimination, admitting its occurrence, was not obtained at the expense of the intestinal excretion, as this was also augmented, and some of the sulphuret was found in the stools. The action of the skin and lungs was probably not diminished; so that there can be no doubt, if the experiments are to be received, that the sulphuret did really increase, to a very great degree, either the elimination of all the constituents or the metamorphosis of probably all the tissues in the body. The most remarkable result was the disproportionate increase of the SO_3. If the experiment be correct, it would show that the sulphuret of antimony either acts specially on the sulphur-containing tissues, or that some of its own sulphur was oxidized. Clare[1] did not notice a similar increase from the use of the sulphuret, and believes that Böcker must have used a preparation containing some uncombined sulphur. It must be said, however, that as far as I have been able to judge of Böcker's accuracy, from a careful study of his numerous writings, I do not think him likely to fall into such an error.

The sulphuret of antimony has of late years almost fallen into disuse, and has been superseded by tartar emetic; but its action is in many respects likely to be so useful in chronic diseases, when it is wished to augment metamorphosis, that it seems unfortunate it has been lately so much neglected.

Arsenic, iron, lead, copper.—When the salts of any of these substances are taken, the metal passes off partly by the urine; but the effect on its constituents is not yet known, nor has the state of combination in which the salts emerge been determined.[2] Salts of iron, especially, augment very largely the iron of the urine,[3] though the amount passing off in this way is not known. Some emerges by the bowels. Lead, although it may pass off in large quantities,[4] does so very much more slowly. In a patient of mine, who had been last exposed to lead on the 20th

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[1] Op. cit., Schmidt's Jahrb., 1855, No. 7.

[2] When the citrate of iron is given to rabbits in very dilute solutions (1 per cent.), it is very rapidly absorbed, and the iron (in the form still of oxide united to an acid) can be detected in the urine in from forty-five to sixty minutes. The amount of urine is increased. Concentrated solutions, on the contrary, lessen remarkably the quantity of the urine, and sometimes even produce bloody urine. Kölliker, in Würzburg Verhandl., Band vi, p. 520.

[3] Michaelis, in Falck's Report on Pharmacology, Canstatt's Jahresb., 1855, p. 96.

[4] Fletcher (Dublin Med. Press, Jan., 1848) found in the urine of a man with lead colic no less than 4·8 grains of metallic lead, in 100 grains of solid matters of the urine.

December, 1852, I found lead in the urine before treatment, on the 16th June, 1853; the blue line was still perceptible along the edge of the lower gum. A peculiar yellowish colour is sometimes observed in the urine, in severe cases of lead colic. The elimination of arsenic is, probably, also very slow. Copper passes off in the urine, as well as in the fæces.

Mercury passes off largely by the kidneys, though it may be detected for a long time after it has ceased to be taken. Its effect on the urinary constituents in health is not yet known. The observations in disease, as far as they have gone, show that it does not, at any rate, increase the amount of these constituents. Thus Hegar,[1] in some syphilitic patients who were more or less salivated, found the urea, the chloride of sodium, and the phosphoric and sulphuric acids in very small amount; not half, in fact, of their normal amount. Of course, much was due here to the meagre diet which patients, with sore mouths, can alone take; but yet the observation is sufficient to show that mercury does not aid urinary elimination in this disease. In a subsequent chapter, I shall have to refer to one or two of my observations in other diseases which corroborate this conclusion.

Many years ago, before the frequency of albuminuria was known, it was stated by Dr. Wells, and by Scudamore, that mercury gave rise to albuminous urine. The point was examined into by Rayer[2] and by Martin Solon,[3] and was found to be incorrect. Dr. Owen Rees,[4] from an examination of fifteen cases, supports Rayer's conclusion, that mercury does not produce albuminuria. Christison,[5] however, has seen temporary albuminuria from mercury; and Thudicum states (p. 408) that, in all cases where the urine contains mercury, a peculiar albuminous substance is present, and also a substance with the reaction of sugar. It is not stated whether these facts have been noted by himself.

Silver.—Silver, in part, issues by the kidneys, and sometimes becomes arrested in the tissues, which it dyes deeply, like the skin and other parts.[6] The combination in the urine is not known.

Zinc.—According to Heller,[7] the oxide of zinc is not absorbed, and no zinc can be detected in the urine. When 120 grains had been given, he was able to recover 116 grains from the fæces.

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[1] Archiv des Vereins, für wiss. Heilk., Band ii, p. 420.

[2] Mal. des Reins, tome i, p. 149, and tome ii, p. 132.

[3] De l'Albuminurie. Paris, 1838, p. 397.

[4] On Diseases of the Kidney. 1850, pp. 27—29.

[5] Monthly Journal, Jan., 1851.

[6] See an interesting case of "Argyria," by Dr. Frommann, of London, in Virchow's Archiv, 1859, Band xvii, p. 135.

[7] Heller's Archiv, 1847, Heft 3.

Sclossberger,[1] however, detected zinc in small quantities in urine, when the oxide was taken; though he found, with Heller, that by far the largest quantity was excreted with the fæces. He believes that it is absorbed into the liver, and passed out with the bile.

Michaelis[2] and Warneke[3] confirm Schlossberger's observations, as far as the urine is concerned.

3. *Non-metallic Elements.*

Sulphur.—It was discovered by Wöhler, that sulphur passed off by the urine (in part, at least) as sulphuric acid. Griffith[4] found that it not only increased the sulphuric acid, but also the sulphur of the urine; and therefore, in part, passed off uncombined. Thus, a man passed in twenty-four hours—

36 grains sulphuric acid,
4 „ sulphur,

before the employment of sulphur. Sulphur being taken, he passed—

76 grains of sulphuric acid,
7 to 8 grains of sulphur.

Beneke[5] and Krause,[6] confirm the fact of the increase of sulphuric acid after the use of sulphur.

Böcker[7] has investigated the effect of sulphur on the constituents of the urine in the person of Dr. Vogt, who took in three days 1½ ounce of sulphur. There was a very slight increase in the urea and uric acid; but the variation was within the limits of possible error, and the increase was therefore immaterial. The effect on the other constituents of the urine was inappreciable. It augmented, however, the intestinal excretions, and also passed off, Böcker believes, in part by the skin.

Sulphuret of Potassium, when not taken in too great quantity, is oxidized, and appears as sulphate of potash in the urine. Its effect on the other constituents is not known.

Iodine appears very rapidly in the urine after being taken,[8] and is in combination, probably, with sodium. Its effect on the urinary constituents is not known. The influence of iodide of potassium is noticed under the head of "Salts."

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[1] Zur Erlauterung der Wirkungen des Zink-oxyd. von Schlossberger. Griesingen's Archiv für phys. Heilk., 1848, Heft 7, 8.

[2] Die phys. Wirk. des Zinc-oxyds, Vierordt's Archiv, 1851, Heft 1.

[3] Schmidt's Jahrb., 1857, No. 4.

[4] Medical Gazette, 1848, March.

[5] Zur Phys. und Pathol. des Phosphors. und Oxals. Kalkes. Gott., 1850, p. 47.

[6] De transitu sulphuris in urinam. Von A. Krause. (Inaug. Diss. Dorpat, 1853.)

[7] Beitrage zur Heilkunde, vol. ii, p. 388.

[8] Bernatzik (Schmidt's Jahrb., 1858, No. 7, p. 22) found that the iodine of the iodide of iron was separated from its base, and rapidly eliminated as a haloid-combination, while the iron passed into other forms, and was finally excreted by the bowels.

Phosphorus.—No experiments have yet been made with this substance. The action of phosphoric acid is given under the head of "Salts."

4. *Inorganic Acids.*

Sulphuric, nitric,[1] *phosphoric,* and *hydrochloric acids,* all emerge by the kidneys, and augment its acidity.[2] This effect increases with the increase of the dose. The acids take alkali from the system; in the case of phosphoric acid, it appears to be potash (Böcker); in the case of sulphuric acid, it is, according to Miguel,[3] soda and potash. The forms of combinations of hydrochloric and nitric acids are not yet known. According to Eylandt, all these acids pass out within twenty-four hours.

The influence of NO_5, SO_3, and ClH, on the other constituents of the urine is uncertain; that of phosphoric acid will be noticed presently.

When neutral sulphates are taken (of soda, quinine, or magnesia), the amount of SO_3 in the urine is much augmented. In the case of sulphate of soda, Buchheim[4] found the amount to be greatly influenced by the time during which the salt remained in the intestines: if it purged and passed out with the stools, much less appeared in the urine; but if the purgative action was restrained with tannin, or still more with opium, much of the sulphuric acid passed by the kidneys. Some of the salt is also decomposed, and forms a sulphuret which emerges with the stools (Duhmberg). When there is no purgative action with a neutral sulphate, I have found the SO_3 to be increased, more than twenty-four hours after the salt had been taken; so that it takes at least this time to be eliminated; and in the case of the sulphate of magnesia, Duhmberg found forty-eight hours necessary. Sick[5] has shown, by a very careful series of experiments, that the SO_3 of the sulphate of soda entirely emerges by the urine if the dose be small; but, at a certain point, it begins to pass off by the bowels. About 1½ gramme (26 grains) of SO_3 can thus pass off in the urine. A higher quantity of the salt than corresponds to this, purges.

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[1] It has been supposed that nitric acid is decomposed in the system, and furnishes oxygen to other substances. It is difficult to disprove or to prove this. It is, however, certain that some of the nitric acid passes out undecomposed, and can be readily detected by the iron, or by Price's, test.

[2] This has lately been completely proved by Eylandt, De acidorum sumptorum vi in urinæ acorem. Inaug. Diss. Dorpat, 1854. In Valentin's Report on Phys., Canstatt's Jahresb. for 1855, p. 104. Dr. Bence Jones has also investigated the effect of sulphuric acid.

[3] Archiv der phys. Heilk., x, p. 479. The experiments were performed on a dog. The soluble salts of the urine were constantly augmented, the bases carried out were soda and potash; and Miguel infers that the blood can thus be made poorer in these alkalies.

[4] Ueber die Wirkung des Glauber-salts, Vierordt's Archiv für phys. Heilk., 1854, p. 93.

[5] Quoted by Scherer, in Canstatt's Jahresb., 1860, vol. i, p. 246.

5. *Vegetable Acids.*

Oxalic, tartaric, citric, acetic acids.—Wöhler first made the now familiar observation, that the vegetable acids, when combined with alkalies, are converted (in the blood, or in the intestines also, or alone, Magawly) into carbonates. When, however, the acids were given in large quantity without alkalies, it was supposed, by Wöhler, that they were not, or were only partly, decomposed, and therefore appeared in the urine.[1] Piotrowsky and Magawly[2] have, from renewed experiments, thrown great doubt on this last statement. According to these observers, oxalic acid (which, from Wöhler's experiments on dogs, was supposed to pass unchanged), when taken in doses of 5 and 7 grammes in twenty-four hours, caused the appearance in the urine of only 0·23 and 0·5 grammes of oxalic acid, combined with lime and with alkalies; the rest was destroyed. The oxalate of soda gave quite as much oxalic acid in the urine as the free acid. Water-free tartaric acid, taken to the amount of 17·25 grammes (266 grains), gave in the urine only 0·306 grammes of acid (4·6 grains), combined with lime. In another experiment, 26·4 grammes gave only 0·862 grammes of water-free acid in the urine. These doses produced copious stools which contained carbonate of lime, but no tartaric acid. When neutral salts were taken, as much undestroyed acid was found in the urine as when the acids were taken pure.

Citric acid was totally destroyed. As much as 60 grammes, taken pure (926 grains), gave no trace in the urine. It is therefore concluded that these acids are oxidized as well without as with combined alkalies.[3] (So far from aiding the conversion, it is indeed conjectured by these authors, that the alkalies, by their affinity for the stronger acid, rather hinder than otherwise its transformation into CO_2.) It is remarkable, however, in these experiments, that a small quantity of oxalic or tartaric acid invariably appeared in the urine, although the amount taken was very various.

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[1] Wöhler and Millon, quoted by Ludwig, Phys., 1st edition, Band ii, p. 272.

[2] Piotrowsky, De quorundam acidorum organicorum in organismo humano mutationibus, Inaug. Diss., Dorpat, 1856. See also Buchheim, in Archiv für phys. Heilk., 1857, p. 122. Magawly, De ratione qua nonnulli sales organ. et anorgan. in tractu intestinali mutantur. Inaug. Diss. Dorpat, 1856. Quoted by Meissner, Report on Phys., in Henle's Zeit., 1856, p. 268.

[3] Experiments by Wagner (Valentin's Report on Phys., in Canstatt's Jahresb. for 1856, p. 98) are confirmatory of the above statements.

Acetic acid is also destroyed in the body; and it is stated by Magawly that malic acid is so, although some part of it may pass unchanged, as stated by Wöhler.

As these experiments appear to have been conducted with great care, and as they were frequently repeated, there would seem no doubt of the incorrectness of the statement that tartaric, citric, malic, and oxalic acids require to be combined with alkali in order to be converted into carbonic acid.

All these acids increase the acidity of the urine (Eylandt), partly by the small amount of undecomposed acid which passes out, but chiefly by the formation of carbonic acid, which in part appears in the urine. The effect of tartaric, citric, and acetic acids, on the composition of the urine, is not known. According to Beneke, oxalic acid, when formed in the body, increases the elimination of earthy phosphates (phosphate of magnesia alone?); whether or not it has this action when it is taken as medicine, is unknown. Buchheim states that it was without influence on the lime in Piotrowsky's experiments; and Wagner also could find no effect to be produced on either the lime or magnesia.

Benzoic acid, and all substances containing benzoyl, or oil of bitter almonds, cause the appearance of hippuric acid, as proved by Ure, Wöhler, and Keller.[1] There is now no doubt that this occurs from the combination of benzoic acid and glycin[2] (glycocoll), though this combination has not yet been effected artificially, external to the body. Thus—

$$\underset{\text{Benzoic acid.}}{C_{14}H_6O_4} + \underset{\text{Glycin.}}{C_4H_3NO_2} = \underset{\text{Hippuric acid.}}{C_{18}H_9NO_6}.$$

The quantity of hippuric acid which is formed, varies very greatly. Duchek[3] has lately asserted that only a limited amount can be formed, as if the body could only furnish a certain quantity of glycin. Thus he found in the urine—

	Hippuric acid.	Benzoic acid.
When 1 gramme of benzoic acid was taken,	0·714	0·000
,, 2 grammes ,, ,, were ,,	1·857	0·421
,, 4 ,, ,, ,, ,, ,,	1·714	2·500

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[1] See Lehmann's Phys. Chem., 2d edit., Band ii, p. 411.

[2] The experiments of Kühne and Hallwachs (Virchow's Archiv, Band xii, p. 386) may be considered to have proved that the union of the benzoic acid and glycin takes place neither in the intestinal canal (bile being excluded) nor in the blood under ordinary circumstances, but in the hepatic circulation, or in the blood, if glycocholic acid or glycin be there present.

[3] Prag Vierteljahisch, 1854, Band iii, p. 25. It should be mentioned that Duchek denies the occurrence of hippuric acid in healthy urine, though he admits its frequent appearance in disease.

Therefore, no more hippuric acid was formed with four than with two grammes of benzoic acid, and the rest passed out unchanged. Piotrowsky's late experiments are, however, opposed to this statement; he found the amount of hippuric acid so great as to lead him to believe that all the benzoic acid was transformed. It is possible, however, that one system might be rich, and the other poor, in glycin. If Duchek's view be correct, it would imply that glycocoll must pre-exist before hippuric can be formed from benzoic acid; and that benzoic acid cannot, as has been supposed, attract the elements of glycocoll to itself, without actual pre-formation of that substance.

The acidity of the urine was found to be greatly augmented by benzoic acid (Ure and Keller); but this is denied by Professor Vogel[1] and Kerner. The amount of uric acid is not lessened,[2] as stated by Ure; nor, according to Lehmann, is the evidence sufficient to prove that the urea is lessened. In four experiments he found no alteration of any nitrogenous substance.

Kerner,[3] from a careful series of experiments carried on for sixteen days (eight days before, eight during use of, from 1·5 to 4·5 grammes, altogether 28·5 grammes, of benzoic acid), found scarcely any difference produced by the benzoic acid on the water, urea, uric acid, chloride of sodium, sulphuric acid, phosphoric acid, earthy phosphates, ammonia, and free acidity. It may be reasonably concluded from these experiments, that benzoic acid produces no appreciable effect on these ingredients.[4]

Cinnamic acid, and balsam of tolu, which contains it, also produce hippuric acid,[5] probably by forming first acetic acid and benzoic acid,[6] thus—

$$\underset{\text{Cinnamic acid.}}{C_{18}H_8O_4} + 4HO = \underset{\text{Acetic.}}{D_4H_4O_4} + \underset{\text{Benzoic.}}{C_{14}H_6O_4} + 2H,$$

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[1] See Kerner, in Archiv des Vereins, Band iii, pp. 618 and 625.

[2] Wöhler and Keller. See Lehmann, Phys. Chem., Band ii, p. 411.

[3] Archiv des Vereins, Band iii, p. 627.

[4] In the sweating caused by benzoic acid, Warneke (Schmidt, Jahrb., 1857, No. 4, and Bibliothek for Laeger, Band iv, p. 167) found benzoate of soda, but no hippuric acid. Schottin has stated the same thing; but G. H. Meissner (quoted in Schmidt, 1860, No. 1, p. 1) has lately rendered it highly probable that hippuric acid does really appear in the sweat, as in the urine, when benzoic acid is taken. Benzoic acid, when taken, is not found in the bile. (Mosler, Virchow's Archiv, 1858, Band xiii, p. 45.)

[5] Erdmann, Marchand, and Ranke, Phys. Chem. Untersuch. Erlangen, 1851.

[6] It may be well to recapitulate the composition of some of these acids, which form parts of a long series:

Benzoic acid	$C_{14}H_6O_4$	Salicylic acid	$C_{14}H_6O_6$
Myroxilic „	$C_{15}H_7O_4$		
Tolulic „	$C_{16}H_8O_4$	Anisic „	$C_{16}H_8O_6$
Cuminic „	$C_{20}H_{12}O_4$		
Copaivic „	$C_{40}H_{32}O_4$	Copalic „	$C_{40}H_{32}O_6$
Cinnamic „	$C_{18}H_8O_4$	Cumarinic „	$C_{18}H_8O_6$

as this composition can be produced by liquor potassæ artificially (Chiozza). Hippuric acid is then formed from benzoic acid and glycin, as usual.

Nitro-benzoic acid ($C_{14}(H_5 NO_4)O_4$) produces nitro-hippuric acid (Bertagnini) by combination with glycin = ($C_{18} (H_8 NO_4) NO_6$).

Salicylic acid has an action which resembles greatly that of benzoic acid, and is of extreme interest. It was supposed by Wöhler and Frerichs[1] to pass out unchanged; but Bertagnini[2] has shown that it does not do so, but that it forms a new acid by combining with glycin (glycocoll), just as benzoic acid combines with glycin to form hippuric acid.

$$\underset{\text{Salicylic acid.}}{C_{14}H_6O_6} + \underset{\text{Glycin.}}{C_4H_5NO_2} = \underset{\text{New acid, salicyluric.}}{C_{18}H_9NO_8}$$

Glycin can be obtained from salicyluric acid.

Tolulic acid,[3] like benzoic and salicylic acid, combines with glycin and forms toluric acid.

$$\underset{\text{Tolulic acid.}}{C_{16}H_8O_4} + \underset{\text{Glycin.}}{C_4H_5NO_2} = \underset{\text{New acid, toluric.}}{C_{20}H_{11}NO_6}$$

Benzoic, salicylic, and tolulic acids, would thus appear to be capable of removing glycin from the body; a fact which may be useful in practical medicine.

Cuminic acid ($C_{20}H_{12}O_4$, or $C_{20}H_{11}O_3 + HO$) passes out unchanged;[4] so also do cumarinic acid ($C\ H\ O$), camphoric ($C_{20}H_{16}O_8$),[5] and anisic acids ($C_{16}H_8O_6$).[6] If the camphoric acid be taken water free, it carries out two equivalents of water.[6]

The effect of these acids on the composition of the urine is totally unknown.

Gallic acid passes unchanged into the urine. It was detected by Hennig,[7] one hour after being taken. Its effect on the urinary constituents in health is not known; from experiments in cases of albuminuria, I do not think it influences at all the elimination of urea or sulphuric acid. Pyrogallic acid passes unchanged (Bernard).[8]

Tannic acid ($C_{18}H_8O_{12}$) passes off by the urine in the forms of gallic and pyrogallic acids, and perhaps of a saccharine body;[9] the change being the same that it undergoes in weak alkaline solutions. Its effect on the urinary constituents is not known. Hennig thinks their quantity is lessened, but the evidence is unsatisfactory.

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[1] Liebig's Annalen, Band lxv, p. 335.

[2] Annalen der Chem. und Pharm., Feb., 1856; and Schmidt's Jahrb., 1856, No. 7.

[3] Krant, Annalen der Chemie, Band xcvii, p. 248.

[4] Hofmann, Ranke, and Kletzinsky.

[5] Liebig's Annalen, Band lxv, p. 335.

[6] Bertagnini, op. cit.

[7] Vierordt's Archiv für phys. Heilk., Jahrg. 12.

[8] Leçons, tome ii, p. 144.

[9] Wöhler and Frerichs, op. cit.

Schottin,[1] according to Lehmann, has noticed allantoin in the urine when large quantities of tannic acid have been taken.

Succinic acid ($C_8H_4O_6 + 2HO$).—This acid was supposed by Wöhler, from one experiment, to pass unchanged. Buchheim,[2] on the contrary, could find no trace of it in the urine, even when it was taken in large quantities. This statement is confirmed by Kuhne.[3] Both observers examined for a conjugate acid of succinic acid and glycin, but could not find one; they found, however, that the hippuric acid was increased. This, however, is doubted by Hallwachs,[4] who could find no increase in the hippuric acid, either in dogs or in his own case. Hallwachs confirms the statement that the succinic acid cannot be detected in the urine.

6. *Animal Acids.*

When *uric acid* or the urates of potash or ammonia were taken, the urea was found to be greatly increased by Wöhler and Frerichs;[5] there were also sediments of oxalate of lime. It was supposed that the uric acid was decomposed in the body, as it is out of it, by oxidizing agents, and formed the same products. The investigations of Neubauer on rabbits[6] corroborate, as far as the urea is concerned, the discovery of Wöhler. Thus, to cite one experiment, the amount of urea excreted by a rabbit being accurately known, 20 grammes of uric acid were given—an amount which could furnish 17·13 grammes of urea. The rabbit passed an excess of 15·95 grammes of urea; a result which proves that the uric acid was almost, if not entirely, converted into urea and carbonic acid. There was no trace of allantoin or hippuric acid in the urine; and Neubauer could not detect any increase of oxalic acid, as in Wöhler's observations. He conjectures that this may have been owing to a difference in the rapidity of metamorphosis, and that while, in his experiments, all the uric acid formed urea, carbonic acid, and water, in Wöhler's experiments metamorphosis may have been less complete, and a certain amount of oxalic may not have been converted into carbonic acid, and therefore was excreted by the kidneys. Gallois[7] did not find any increase of urea, or any oxalate of lime, after giving urate of potash to a rabbit and a dog. These experiments, however, cannot be put against the positive observations of Neubauer.

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[1] Lehmann's Handbuch der phys. Chem., 1859, p. 93.

[2] Archiv. für phys. Heilk., 1857, p. 142.

[3] Archiv für path. Anat. (Virchow's), Band xiv, pp. 399 and 400.

[4] Ann. der Chem. u. Pharm., Band cvi, p. 160.

[5] Liebig's Annalen, Band lxv, p. 335.

[6] Ibid., Band xcix, p. 206.

[7] Compt. Rend., 1857, April.

Hippuric acid, according to Schwarz,[1] Piotrowsky, Magawly,[2] and Buchheim,[3] passes unchanged into the urine.

Lactic acid is chiefly decomposed, perhaps even in the stomach. Whether or not any passes into the urine is uncertain.

7. *Alkalies.*

Liquor potassæ.—The effect of this medicine has been examined by the author.[4]

When it was taken on a fasting system, so that it might, as far as possible, escape neutralization in the stomach, it appeared to pass out by the urine in a few hours (six?), in two experiments. From an expression of Buchheim's, I infer that he doubts this rapid passage; and certainly, as only two experiments were made, it would be desirable to repeat the analyses.

1. The water of the urine was variably affected; when a single large dose (2 drachms) was taken, the water was in two experiments greatly increased, in three others in a less degree: this effect occurred within six hours. When the liquor potash (6·7 per cent. of pure potash) was given in small doses (10 to 20 minims) three times during the day, no effect could be perceived in the urine of twenty-four hours. Either the water-excreting action was therefore caused by some other unrecognised circumstance, or the copious excretion was followed by a lessened amount, so as to equalize the previous larger quantity.

2. The condition of the urea was doubtful. In several patients who were treated for trifling complaints, and who might be considerered healthy, the amount of urea in twenty-four hours was increased; and this occurred so constantly, as to lead to the inference that the alkali really augmented the formation of urea. But on reconsidering these experiments, with the better knowledge which succeeding years has given us, I am of opinion that they do not prove this point, but merely render it probable. Numerous as they are, the experiments were not continued a sufficiently long time on the same individual: they all require to be repeated.

3. The uric acid was apparently unaffected.

4. The extractives were not determined; but the colour of the urine was decidedly lighter, independent altogether of the increased water; so that it may be conjectured that the pigment

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[1] Liebig's Annalen, Band liv, p. 32, quoted by Buchheim, in Archiv des Phys. Heilk., 1857, p. 141.

[2] Quoted by Meissner, Report on Phys. for 1856. Henle's Zeitschrift, 1857, p. 270.

[3] Archiv für phys. Heilk., 1857, p. 142.

[4] British and Foreign Med.-Chir. Rev., January, 1853, and succeeding numbers.

was not increased. At the same time, in two experiments the amount of organic matter, not urea or uric acid, was decidedly large.

5. The *chloride of sodium* was sometimes increased, occasionally unaffected; and its variations were probably owing to other causes.

6. The *sulphuric acid* was increased in all my experiments; and it appeared almost certain, from the constancy of this occurrence, that the sulphur-holding tissues were especially acted upon by the potash. The amount of increase was variable, sometimes very great, sometimes slight; on only one occasion was it extremely slight. These experiments have been repeated by Clare on himself,[1] and have not been confirmed. The SO_3 was not altered by 2—5 drachms of liquor potassæ in five experiments. At the same time, it is not certain whether Clare attended to the important rule of introducing the alkali into a completely empty stomach. I have, unfortunately, not been able to repeat my experiments since Clare's results were made known. An observation of Beneke, on a case of disease of the skin, is confirmatory of my statement. The SO_3 was largely increased.

7. The *phosphoric acid* was increased, in several of my experiments, to a variable extent; sometimes slightly, sometimes rather considerably; and it appeared to me, that when it was much increased, the SO_3 was less so, as if, according to circumstances, the potash passed off now more with phosphoric acid, another time with sulphuric acid to a greater extent.

8. The effect on the bases was not determined; but as the potash seemed to increase the total amount of acid in the urine, it may perhaps be inferred that it did not rob any other base.

9. The *free acidity*, in two cases of slight *disease*, was equal, in twenty-four hours, to the following amount of crystallized oxalic acid. The amount of liquor potassæ was 2 fluid drachms and 1½ fluid drachm in each twenty-four hours:[2]

	Before liq. p.	During liq. p.	After liq. p.
In a case of slight chronic eczema, the man really healthy	62·779[3]	56·446[4]	56·64[5]
In a case of phthisis . . .	32·959[6]	28·624[7]	22·267[8]

So that the free acidity was lessened in a very inconsiderable degree in these two cases, which for our purpose may be considered healthy.

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[1] Op. cit., and Schmidt's Jahrb., 1855, No. 7, p. 7. The amount of SO_3 in Clare's urine appears singularly constant, even under great variations of diet and exercise.

[2] London Pharm. strength 6·7 per cent. of pure alkali.

[3] One observation.

[4] Eleven observations.

[5] Seven observations.

[6] Five observations.

[7] Five observations.

[8] Eleven observations.

10. *Abnormal constituents.*—Liquor potassæ did not cause the appearance of albumen. It was surmised that there was some organic acid in the urine, but it was not isolated. Prout (5th edit., p. 564) believed oxalic acid to be formed by the free action of liquor potassæ.

Ammonia would appear, from Dr. Bence Jones' observations,[1] to be oxidized in the system, and to appear as nitric acid in the urine, the acidity of which is of course augmented by it. This conclusion has been denied by a pupil of Lehmann's, who affirms that the reaction ascribed by Bence Jones to nitric is really attributable to sulphurous acid. At present the point must be considered to be undecided, but the weight of evidence certainly appears to bear out Dr. Bence Jones' views.[2] There is no doubt, however, from Neubauer's observations, that the salts of ammonia do not always form nitric acid, since the hydrochlorate passes out unchanged; therefore if ammonia meet with hydrochloric acid in the stomach, it will pass out without forming nitric acid. The effect of ammonia on the urinary constituents is uncertain.

8. *Salts.*

No medicines are so frequently used as the various salts, and none are more satisfactory in their results. This is generally ascribed to their diuretic influence, *i. e.* to their power of increasing in some way the urinary excretion, either by direct action on the structure of the kidney, or by augmenting, by their combination, the diffusion power of effete substances, or by actually increasing the amount of these effete substances, by hastening metamorphosis. It must be confessed, however, that although the practical use of these substances is undoubted, we are not thoroughly acquainted with all the details of their action even on the urine, and we are still less prepared to trace their progress and successive changes in the interior of the body. Their action on the constituents of the blood and organs is indeed a matter of great obscurity, and nothing could at present justify any attempt at minute explanation. The laws of the diffusions of salts, although in part known by the beautiful investigations of Graham, are still too incomplete to permit us to apply any rules to the living membranes. Still, something is known which may be of use in practice, or which may lead us to hope that scientific explanation will soon aid therapeutical employment.

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[1] Phil. Trans., 1850. p. 669, and 1851, p. 399.

[2] Thus, Neubauer (Anleit., 2d edit., p. 59) has pointed out that sulphurous acid does not give the reaction which Bence Jones relies on to prove NO_5, and that, therefore, the experiments above alluded to do not disprove Bence Jones' statement.

Although it is not to be expected that the various salts will act in the same manner as their separate constituents, it would be advisable to know how the acids and their bases separately affect the urine, before proceeding to the more complicated inquiry into the action of the combined substances, as it is possible that the salt may decompose in the body into its components. In many cases, however, it does not do so, and the action of the components separately would be no guide to their action when united.

The salts of soda.—The effect of the *chloride of sodium* has been already considered (p. 65). The *carbonates of soda* are very rapidly excreted by the kidney, and render the urine alkaline, more or less rapidly, according to its condition at the time. The soda is probably excreted in the form of carbonate or bicarbonate. The effect on the urinary constituents is not yet known.

Beneke[1] found that the earthy phosphates were increased: but Wagner's experiments[2] are not confirmatory; he noticed no effect to be produced either on the lime or magnesia.

The nitrate of soda passes out by the kidneys. According to Beigel,[3] in doses of 3 drachms daily; it did not produce any decided effect on the water or on the urea. Schirks,[4] however, by a careful series of experiments, conducted for fourteen days, claims to have made out that both the water and the urea are at first slightly increased, but that after the salt has been taken for three or four days, the amount both of the water and urea falls below the standard, to an extent which balances the previous increase. The medicine, therefore, at first acts as a diuretic, increasing the amount of water, and thus aiding the elimination of urea; but this influence is limited and temporary, and the experiments, if correct, imply that the salt is a mere eliminator, and that the formation of urea in the body is not augmented. The quantities given by Schirks are—

Mean daily Excretion.

	In 7 days without medicine.	In first 4 days, with ℥iss of nit. soda daily.	In next 3 days with the same amount of nit. soda.
Water	1080 c.c.	1200 c.c.	991 c.c.
Urea	31·3 grammes	35· grammes	28·5 grammes

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[1] Oxalurie, p. 33.

[2] Valentin's Report on Phys., in Canstatt's Jahresb., 1856, p. 99.

[3] Op. cit.

[4] Exper. nonnulla de Natri nitrici, &c. Inaug. Diss., auctore Ant. Schirks, 1856. Quoted in Schmidt's Jahrb., 1857, No. 3, p. 357. The original treatise is unknown to me.

Phosphate of soda and phosphoric acid.—The influence of these substances has been investigated by Böcker;[1] and as their actions have a certain resemblance, it will be well to put them together. Hammond[2] and Sick[3] have also examined the effect of the phosphate of soda

To refer, in the first instance, to Böcker's experiments. Phosphoric acid, when taken pure, passes out combined. The alkali it carries out is almost entirely potash, in Böcker's own case; it may possibly be soda in other persons; the acid does not take lime or magnesia.[4] The phosphoric acid of the urine is, of course, greatly augmented; thus, if 100 drops of phosphoric acid (containing 0·967 grammes of water-free acid) or 15 grammes of phosphate of soda (containing 2·609 grammes of water-free acid) be taken, the following excretion was produced in six hours.

In six fasting hours there were excreted, under the following circumstances—

			PO_5.
Normal with	250 grms.	of water	0·378 grms.
”	500	”	0·464 ”
PO_5 100 drops, and	250	”	0·923 ”
” ”	500	”	0·829 ”
15 grms. phosphate soda and	250	”	1·278 ”
” ” ”	500	”	1·063 ”

The remarkable result was brought out, that the excretion of the phosphoric acid was not so great with the larger as with the smaller quantity of water.

The rapidity of elimination appears to be generally as follows, both for PO_5 and (PO_5+NaO): in six hours, from one third to five ninths were eliminated; and in eighteen hours rather more than two thirds were excreted; one third was excreted at a later uncertain period. The rapidity, however, was greatly augmented by albumen (white of egg): thus, when no albumen was taken, 2·090 out of 2·985 grammes of acid were excreted in eighteen hours; when albumen was taken, 2·660 out of 2·985 grammes were eliminated in the same time.[5]

Water-drinking and food appeared, therefore, to have opposite effects, but the experiments on this point are not numerous.

As, in passing out from the system, phosphoric acid takes (in

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[1] Prag Vierteljahrschrift, 1854, and Archiv des Vereins zur forderung der wiss. Heilkunde, Band ii, p. 182. I have given a full abstract of his paper, without being able to vouch for the statements.

[2] American Journal of Med. Science.

[3] Archiv für phys. Heilk., 1857, p. 482.

[4] In his first paper, Böcker thought the magnesia increased, but his later experiments show that this is not the case.

[5] According to Böcker, the effect of albumen *per se* is to diminish the PO_5.

Böcker's own case) potash as its base, it therefore causes the elimination of this alkali.

In eighteen fasting hours.

	Under normal circumstances.	With PO_5 100 drops.	Increase of Potash. from PO_5.
Potash	2·963 grammes	3·998 grammes	1·035 grammes.

Thus, 14·89 grains of water-free phosphoric acid eliminated 15·98 grains of potash from the body in eighteen hours.

It might be presumed, therefore, that the administration of phosphoric acid would tend to carry off so much base as in part to *de-alkalize* the body, if such a term may be admitted. But this presumption is incorrect; for Böcker has discovered the singular fact, that PO_5 diminishes very greatly the elimination of chloride of sodium; to such an extent, indeed, that, in spite of the increased excretion of potash, *the total amount of alkali leaving the system is diminished;* so that phosphoric acid must actually heighten the alkalinity of the body ! (?)

The same effect is produced by the phosphate of soda; and, up to the present time, these two substances (PO_5 and PO_5+NaO) are the only medicines which are said to have the power of lessening the egress of chloride of sodium.

After taking phosphoric acid the body is, therefore, much more rich in soda than before, though poorer in potash; and if at any time an indication should arise for altering the amounts of these two substances in the body, we appear to have a mode of doing it without giving the substances themselves.

The phosphate of soda acts in the same way. The excretion of potash is increased, that of soda diminished. There is an interchange of bases in the body; the soda leaves the phosphoric acid, which unites to potash, and passes into the urine. Böcker has made no less than fifty-one experiments to prove this; he found the result constant. Neutral phosphate of soda entered the blood, but phosphate of potash (PO_5+2KO) quitted it.[1]

The excretion of potash was affected by water; it was much less with PO_5 and 500 grammes of water than with 250 grammes.

PO_5 and PO_5+NaO exerted no effect on the elimination of *sulphuric* acid.

PO_5 sometimes diminished, sometimes slightly increased the *magnesia;* it diminished the *lime* always. PO_5+NaO diminished both.

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[1] It remains to be proved whether this result will hold good for other persons. The salts in Böcker's urine are possibly rather peculiar; the phosphoric acid is always united to potash, whereas in most cases it is supposed to be joined chiefly to soda.

The *urea* was diminished by PO_5NaO, as is shown by the following table:

	Inanition for 6 hours.		White of eggs (100 grms.) as food—6 hours.		In 18 hours.	
	Without PO_5NaO.	15 Grammes PO_5NaO.	Without PO_5NaO.	15 Grammes PO_5NaO.	Without PO_5NaO.	15 Grammes PO_5NaO.
Urea	Grammes 5·7	4·6	7·6	4·6	22·5	20·5

Therefore, in eighteen hours, PO_5NaO checked the elimination of urea by 30 grains.

This result is in part attributed, by Böcker, to the interference by the phosphate with digestion; as has been pointed out by Nasse, it retards extremely the digestive process, and lessens the amount of nutriment entering the system. But, as appears from the inanition experiment, it also lessens the urea, when it could not, of course, do so by interference with digestion.

If this be the case, the phosphate of soda lessens excretion, not only by lessening metamorphosis, but by hindering supply.

In Schirks'[1] experiments there was a very slight increase in the urea, but to an extent within the limits of urea; so that no weight can be given to the observation.

Phosphoric acid, on the other hand, does not affect the urea; it does not, either, affect digestion.

With respect to *uric acid,* it was found to be always increased by PO_5, but not to any extent; to be sometimes diminished, to be less often increased, by PO_5NaO. Falck has stated that PO_5NaO increases the uric acid, but he has produced no facts in support of the assertion.

PO_5 increased the iron of the urine.

PO_5NaO had no effect on it.

The effect on the extractives was variable.

PO_5NaO diminished *the water of the urine;* so far from being a diuretic, its action is then precisely the reverse.

PO_5 has no constant influence on the water. The following table from Böcker shows this:

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[1] Schmidt's Jahrb., 1857, No. 3, p. 358.

In six hours.

	Water of urine.	Solids of ditto.	Remarks.
	Grammes.	Grammes.	
Normal, with 500 grammes of water	311·080	13·918	Experiments made in 1853.
With PO_5 ,, ,,	335·050	13·950	
With PO_5NaO ,, ,,	223·287	12·713	
Normal, with 500 grammes of water and 15 grammes water-free albumen	516·035	15·965	
With PO_5 ,, ,,	308·000	15·000	
With PO_5NaO ,, ,,	254·184	13·816	

Neither PO_5 nor Po_5NaO lessened the temperature of the body; PO_5NaO lessened the insensible perspiration, and diminished the loss of body-weight consequent on inanition.

Few decided therapeutical indications can be drawn from this elaborate investigation; but it seems clear that we cannot look upon phosphate of soda as a disintegrating agent, but rather the reverse, for it lessens both the urea and insensible perspiration. Nor does PO_5 have any decided influence on the urea and uric acid.

Hammond confirms the statement, that the phosphoric acid of the phosphate of soda passes out, in great measure, by the urine. Not altogether, however; for if 3·838 grammes of phosphoric acid were introduced, only 2·948 grammes were excreted by this channel. Sick, on the contrary, not only found that all the phosphoric acid contained in the salt passed out in the urine, but that the normal phosphoric acid of the urine was itself slightly increased. The quantity of urine was also slightly augmented (123 c.c. daily); and, after making the necessary allowance for varying temperature, Sick believes that this was owing to the salt, and that the phosphate of soda is really a slight diuretic, as far as water is concerned. The increase, however, is so trifling, as to fall, it appears to me, within the limits of unavoidable error. The phosphoric acid was excreted in combination with alkalies; the amount of earths was lessened.

Salts of potash.—Like the carbonate of soda, the *carbonate of potash* rapidly renders the urine alkaline, though the amount required for this differs much in different persons. It is not yet known whether or not the potash emerges in any other form than that in which it entered. Although its immediate effect is thus to cause alkalinity, it does really, in some diseased conditions, augment the absolute quantity of acid excreted; for the acidity of the urine is found, after the salt has been left off, to be greatly increased.[1] The effect on the various urinary constituents in health has not been well made out. Some few observations have been made in disease.

Nitrate of potash is a medicine which deservedly holds a high rank among the antiphlogistic remedies. It is very rapidly excreted by the urine,[2] the acidity of which it does not destroy.

Beigel has lately examined its effects in four healthy men.[3] Three drachms were given in each twenty-four hours; the results were contradictory: the quantity of urine was unaltered in one, was lessened in two, was increased in one; the urea was unaffected in one, was diminished slightly in one, and greatly in the other two. If these observations can be trusted, nitrate of potash in the healthy subject is not only not a diuretic, but it absolutely either lessens the production of urea, or hinders its elimination. But none of Beigel's experiments appear very trustworthy.

In 1852, I made some experiments on myself, which are to some extent opposed to Beigel's statements.[4] I subjoin a table showing the results.[5] When one ounce of nitrate of potash was taken in twenty-four hours, there were excreted—

	Water.	Total solids.	Solids per hour.	Sulphuric acid.	SO_3 per hour.
	Ozs.	Grains.	Grains.	Grains.	Grains.
In the first 24 hours during which the medicine was taken ...	53½	982·98	40·95	28·673	1·194
In the second 24 hours	39	759·21	31·62	21·937	0·914
" third "	42	1120·95	46·70	20·071	0·836
" fourth "	27	666·32	27·76	25.600	1·066
" fifth "	37½	713·50	29·72	20·052	0·835
" sixth "	40	730·52	30·43	22·464	0·936
Mean of the 6 days ...	40	828·86	33·54	23·132	0·953
Normal mean immediately before	40	635·64	26·12	20·686	0·856
Daily excess on 6 days, ℥j of nitrate having been taken on the first day	0	193·22	7·42	2·446	0·097

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[1] In the section on "Gout," a case of this kind is referred to, and the numbers there given will illustrate this statement. Beneke has made a similar observation, but I cannot find the passage.

[2] See an interesting paper by Dr. Basham (Med.-Chir. Trans.), on the Use of Nitrate of Potash in Acute Rheumatism.

[3] Untersuch., &c., Aus. Nova Acta, Band xxv.

[4] When these experiments were made, the new modes of determining the urea and chlorine, &c., by volumetric methods, had not been invented. I restricted my observations, therefore, to the substances which were capable of accurate and rapid determination, viz., the solids and the SO_3.

[5] The nitrate of potash was pure—it was tested especially for sulphates.

That is to say, while the urinary water was not altered, 1159 more grains of solids were passed during the six days, than would have been the case without the nitrate; and if we deduct 480 grains as the amount of the nitrate, it leaves an excess of 679 grains, or 112 grains per diem, of excess of excretion over the former period when no medicine was taken. The daily increase of the SO_3 (2½ grains) would imply that this was in part owing to augmented disintegration of albuminous substances. It is interesting to observe, that the effect of the nitrate was not transient; it lasted through the six days, and was even, as far as the solids were concerned, greater twenty-four to forty-eight hours after the medicine was left off, than in the twenty-four hours while it was being taken. It was, probably, itself excreted in greater part during the first forty-eight hours.

I do not say that this single experiment is at all sufficient; judged by Radiche's rules, it is seen to be very far from sufficient; but it certainly makes me doubt whether Beigel's observations are enough to show that nitrate of potash does not increase metamorphosis in health. I shall have to refer to a case of rheumatic fever, in which the nitrate caused an increase of sulphuric acid, as in my case.

Some later experiments, by Schirks,[1] tend to show that the effect of the nitrate of potash is the same as that of the nitrate of soda, viz. that the water and the urea are at first increased, but that, although the salt is continued, the effect is temporary, and after a few days the water and urea fall in a corresponding degree below the average amount.

Acetate of potash.—The late Dr. Golding Bird, in his very instructive lectures delivered before the College of Physicians, in 1848;[2] and again in the last edition of his book on 'Urinary Deposits,' referred to the "blood depuration" which is caused by the action of certain remedies, especially the alkalies and the salts which become alkaline in the system, as the acetates, citrates, and tartrates of alkalies. With many of the opinions so lucidly laid down by that physician, who was too untimely removed from among us, all must cordially agree. It must be said, however, that the evidence produced in support of the view that acetate of potash is a "blood depurant," and increases metamorphosis and urinary excretion, is not very stringent. Only one case of disease is reported by Golding Bird ('Urinary Deposits,' 4th edit., 1853, p. 430), in which a single day's observation, without medicine, is compared with a single day when three drachms of acetate of potash were taken. On the latter occasion, there was an increase of water and of solids, and among these, of urea, uric acid, salts, and extractives. It is possible the increase may have been owing to the remedy; but as great a difference is often seen between any two days in persons who have taken no medicine. A single case can never prove so important a point. Dr. Bird refers to other cases of disease which occurred to him, but does not give the evidence on which his statements are based.

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[1] Valentin's Report, Canstatt's Jahresb. for 1857, Band i, p. 84.

[2] Medical Gazette, 1848. Dr. Bird, in speaking of certain reputed diuretics which "increase the metamorphosis of tissue, and act as depurating agents," says, "This class includes the alkalies, their carbonates, and their salts, with such acids as in the animal economy are capable of being converted into carbonic acid, including the acetates, citrates, tartrates of soda and potass. These remedies all act alike; they all actively stimulate the excreting function of the kidney, and increase the bulk of the urine; but they do more, they actually increase the metamorphosis of tissue by, in all probability, a direct chemical action on the elements of worn-out and exhausted tissues."

Very different from Dr. Bird's conclusions are the results arrived at by Böcker.[1] Two series of experiments were made on two healthy young men. In one, on a mean of four days, during which three ounces of liquor potassæ acetatis of the Prussian Pharmacopœia were taken, the difference between the normal excretion and that caused by acetate of potash was, that in the last case there were excreted—

	More grammes.	Less grammes.
Urine	...	36·250
Solids	13·880	...
Urea...	...	0·761
Uric acid	0·204	...
Mucus	0·167	...
Fireproof salts	14·472	...
Earthy phosphates	...	1·504
Volatile salts and extractives	...	0·202

So far from acting as a diuretic, the acetate of potash *diminished* the water, the urea, the extractives, and, in a remarkable manner, the earthy salts. The total solids and fire-proof salts were increased, but this was doubtless from the excretion of carbonate of potash formed by the acetate.

The experiment in the second man was made by continuing the acetate in rather smaller doses for eleven days.

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[1] Beitrage zur Heilkunde, vol. ii, p. 246.

The following table gives the mean results:

Constituents.	In normal condition—10 days.	With acet. potash; mean of 11 days.	Increase with acetate.	Decrease with acetate.
Water	1503·132	1709·191	206·059	...
Solids	53·368	55·354	1·986	...
Urea	11·996	8·198	...	3·798
Uric acid	0·008	0·000	...	0·008
Fireproof salts ...	27·609	34·542	6·933	...
Phosph. of lime ...	0·807	0·745	...	0·062
„ magnesia	0·433	0·162	...	0·271
Volatile salts and extractives	13·756	12·614	...	1·142

The urea and uric acid rapidly decomposed in the alkaline urine. This experiment entirely confirms the inference drawn from the former series.

In 1852, I made some experiments on myself, to determine the amount of water solids, and sulphuric acid excreted, when acetate of potash was taken. The results are given in the table at p. 168.

The slight increase in the solids was, doubtless, owing to the appearance of carbonate of potash in the urine; if allowance is made for this, it is found that the solids were really lessened somewhat by the acetate, and so also was the sulphuric acid to a slight extent. The water also was not increased, or very slightly so, as an additional quantity was taken with the medicine. It will be observed, that the decrease in the SO_3 was most marked when the acetate was first taken, and that the hourly mount gradually rose day by day, till, on the third day, it reached its normal standard. Still, even these variations were within the physiological range; and I hesitate to assert that the SO_3 was lessened, but it certainly was not increased.

These experiments, incomplete as they are, are therefore so far confirmatory of Böcker's, and show, that while no great effect is produced by the acetate of potash in health, its tendency is rather to lessen than to increase the excretion of urinary solids. Yet, decidedly, acetate of potash will sometimes act on the water. Thus, Ranke[1] found, in a man in whom the anterior walls of the abdomen and of the bladder were deficient, that 1 ounce of the liq. pot. acet. of the Prussian Pharmacopœia increased the urinary flow greatly, so that in three hours as much was passed as ordinarily in sixteen. The amount of the solids was not determined.

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[1] Phys. Chem. Untersuch. Erlangen, 1851.

The acetate produces one constant effect; it is transformed into carbonate, either in the alimentary canal[1] or in the blood-vessels or lymphatics, and renders the urine alkaline. The rapidity with which it does so depends on individual constitution, and on the condition of the person at the time: no constant results are obtained. In the case just referred to, Ranke found the urine made neutral in ten minutes, and alkaline in twenty-five minutes, by 1 ounce of the liq. pot. acet. of the Saxon Pharmacopœia. The urine was tested as it dropped from the ureters; so that the fallacy which would have been caused by its admixture with acid urine already in the bladder was avoided.

The *citrate* and *tartrate of potash* produce, like the acetate, alkalinity of the urine, from the formation of carbonate. The amount of free CO_2 in the urine is also greatly increased (Planer). When taken in large doses, not too soon after a meal, the alkalinity is produced in from twenty-eight to forty minutes.[2]

It may possibly cause some surprise to find that most of the evidence as yet available is opposed to the hypothesis that, in the healthy body, acetate of potash will increase the solids of the urine, or even the water, as a constant rule. The commonly received (and possibly correct) opinion, that the carbonates of alkalies increase tissue change, and the fact that the acetate is converted into carbonate in the system, led naturally to the conclusion that the action of the one salt must be analogous to that of the other. Still, experiment does not, so far, support this supposition; and it may be, that the very conversion of the acetate into carbonate produces an aberration, so to speak, from the normal course of metamorphosis and oxidation which may impede the formation and elimination of urea.

In disease the diuretic influence may be more marked, but, I must confess, it has not always been so in my experience, and few remedies have appeared to me to be more uncertain in their action on the amount of urine. Its akaline effect is, however, always certain.

Iodide of potassium.—When the iodide is swallowed, iodine can be speedily detected in the urine (in three and a half minutes by Ranke[3]), though not so soon as in the saliva;[4] according to Bernatzik,[5] it is eventually almost entirely excreted from the kidneys, as that thrown out by the saliva is again absorbed. The amount that can pass off by the kidneys in 24 hours is not yet accurately known. Buchheim conjectures that it is closely connected with the weight of the body. Dogs and cats remain quite healthy as long as the iodide given daily does not exceed half a grain to each kilogramme of body-weight. If this be the case, a man weighing 60 kilogrammes would excrete 30 grains daily, and not be iodized. But many are iodized with much smaller quantities. It can be found in the urine for many days when a large dose is taken (Christison); and even after a small dose, a small portion can be detected for four or five days.

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[1] The experiments conducted under Buchheim's direction (Ueber die Bildung Kohlens. Salze im Darmkanale, Archiv für phys. Heilk., 1857, p. 234) prove that the transformation into carbonates takes place, in some measure in the alimentary canal.

[2] Erichsen, Philos. Trans., 1845.

[3] Phys. Chem. Untersuchungen. Erlangen, 1851.

[3] Bernard, Archives Générales, 1853.

[4] Schmidt's Jahrb., 1858, No. 7, p. 23.

Ranke found the urinary flow greatly increased by the iodide, in a man with open bladder, on whom he experimented. There was great contraction of the ureters. Handfield Jones,[1] in some cases of disease, found the urine greatly increased in three cases, slightly increased in one, lessened in two. The observations extended, however, only over two days (one before, one during, use of the iodide). Arneth and Pelikan[2] found no increase of water; and in several cases of slight disease (the patients might be termed healthy,) I have observed no such effect. Handfield Jones, in the paper already referred to, examined the effect produced by one day's use, on the urea, phosphoric and sulphuric acids, the chlorine, the uric acid, and the free acidity. The results were very contradictory, and the subject must be considered still obscure. I could not discover that any effect was produced on the sulphuric acid.

Iodide of potassium eliminates from the body mercury, (Melsens) and lead (Sieveking, Malherbe,[3] Œltingen,[4] and author[5]).

Chlorate of potash.—Isambert[6] states, that 20 grammes of the chlorate of potash heightened the acidity of the urine, and increased the deposit of urates and pigment. Whether it augmented the absolute quantity of these substances does not appear.

Sulphocyanide of potassium passes out unchanged.[7]

Ferrocyanide of potassium becomes ferricyanide.

Salts of ammonia.—Whatever may be the case with the liquor ammoniæ and the carbonate, it seems, from Neubauer's experiments, that the muriate of ammonia is not oxidized, but passes out unchanged by the urine; for 9·957 grammes were recovered from the urine of a patient who had taken 10 grammes in five days.[1] Others, however (G. Scott), have recovered very little ammonia.

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[1] Archives of Med., vol. i, p. 181.

[2] Schmidt's Jahrb., 1858, No. 7, p. 24.

[3] Gazette des Hôpitaux, Dec., 1854.

[4] Schmidt's Jahrb., 1857, No. 7, p. 26.

[5] Brit. and Foreign Med.-Chir. Rev., 1853.

[6] Etudes chimiques, phys. et clin. sur l'emploi thérapeutique de Chlorate de Potasse. Paris, 1856.

[7] Wöhler and Frerichs, Liebig's Annalen, Band lxv, p. 335.

According to Böcker,[2] it increases all the constituents of the urine, except the uric acid, which it slightly diminishes. The mean daily increase of the urea in these experiments was 4·793 grammes, or 74 grains—an amount which indicates a vast augmentation of metamorphosis or of elimination. It is very desirable these observations should be repeated. The volatile salts and extractives were increased by no less than 18·959 grammes, or 292 grains, which was no doubt partly owing to the presence of the volatile chloride of ammonium.

The tartrate of ammonia does not increase the acidity of the urine.[3] Prout[4] noticed a great increase of urea in a dyspeptic patient, from citrate of ammonia.

Salts of lime.—The use of phosphate of lime has been strongly recommended by Beneke and others in all cases in which cell-building is impeded by the insufficient ingress, or too great egress, of the phosphate.

The influence of phosphate of lime ($2CaOPO_5 + 5HO$), prepared by precipitation, on the phosphoric acid of the urine, has been examined by Hegar,[5] who doubts the accuracy of Beneke's views; and believes that, in many cases, the phosphate of lime is *not absorbed from the alimentary canal,* but passes off with the stools. It was, at any rate, not excreted with the urine; for the phosphate of lime actually diminished the phosphoric acid of the urine, as will be seen by the annexed table.

In twenty-four hours were excreted, with and without the use of phosphate of lime (dose from 1 to 4 scruples)—

No.	Age.	Without PO_5Ca.			With ℈ij PO_5CaO.			Total increase with $CaOPO_5$.	Total decrease with $CaOPO_5$.
		PO_5 with alkalies.	PO_5 with earths.	Total PO_5.	PO_5 with alkalies.	PO_5 with earths.	Total PO_5.		
1	36	2·592	0·360	2·952	2·136	0·346	2·472	. .	0·480
2	25	3·340	1·310	4·640	3·010	1·030	4·040	. .	0 600
3	. .	. .	. .	3·800	. .	. .	3·440	. .	0·360
4	23	. .	. .	3·730	. .	. .	4·030	0·300	.
5	23	1·910	0·750	2·640	2·060	0·50	2·550	. .	0·090

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[1] Anleitung, &c., p. 59.

[2] Beitrage zur Heilk., vol. ii, p. 150.

[3] Bence Jones, op. cit.

[4] On Stomach and Renal Diseases, 5th edit., p. 95, foot-note. Prout suggests that the ammonia was converted into urea. It is, perhaps, more probable that metamorphosis or elimination was increased.

[5] Zur Wurdigung der phosphorsauren Erden, von Dr. A. Hegar, Archiv des Vereins für wissens. Heilk., Band ii, p. 420.

In another experiment, in which, in two days, 22 grammes (5½ drs.) were taken in repeated small doses, the earthy phosphates were increased, but not the alkaline; about one sixth part of the phosphoric acid passed off through the kidneys.

The diminution of the urinary phosphoric acid is ascribed, by Hegar, to the disturbance of digestion produced by the phosphate of lime, by which even the solution of earthy salts present with the food may have been impeded.

The quantity of urine and the solids were increased; the effect on the other ingredients was not determined.[1]

Neubauer has also examined the effect of phosphate of lime on the phosphates of the urine, and finds that it passes in very small quantity, and that the amount of the excreted phosphates undergoes no appreciable increase.[2]

Lactate of lime.—Wagner[3] found the lime augmented only slightly, after lactate of lime was taken: the magnesia was unaffected.

Chloride of calcium.—The amount of lime considerably increased. The magnesia was slightly increased. The acidity was lessened.

9. *Alkaloids and neutral Vegetable Principles.*

Quinine and cinchonine.—Both these alkaloids pass off in the urine in part (Wöhler, Briquet, Herapath, and others). Briquet states that half passes into the urine. Herapath recovered only 25 per cent.

Kerner[4] also noticed that some is destroyed in the body, and that the amount depends on the greater or less respiration power. In general terms, he finds that a respiration power of 3000 c.c. (*i. e.*, vital capacity of 180 cubic inches, as determined by the spirometer) can destroy 15 grains of sulphate of quinine in twenty-four hours; any amount over this will pass into the urine.

Briquet could detect none in the perspiration, and, unless very large quantities are given, none passes by the intestines.

In healthy persons quinine appears in the urine in the course of two to five hours, but more quickly in young than in old persons. In some diseases (intermittents, pulmonary emphysema, pneumonia, morbus Brightii) its exit is much delayed;[1] and in three cases, in which large doses were given, it could be detected in the urine by Dietl for many weeks after the last dose. This would certainly indicate that it is not easily destroyed in the body; it may be in a state of very stable union, and possibly, by prolonging the analyses, more might be recovered than was done by Briquet and Herapath.

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[1] Beneke has replied to this paper by Hegar, and points out that Hegar has produced no evidence which can be put in opposition to the positive and abundant testimony of the excellent effects which follow the administration of phosphate of lime in the cases in which it is indicated, especially in tuberculous, scrofulous, and rachitic diseases. After all, we must be guided by clinical experience.

[2] Canstatt's Jahresb., 1856, Scherer's Report on Phys. Chem., p. 185.

[3] Valentin's Report on Phys., Canstatt's Jahresb., 1856, Band i, p. 99.

[4] Corresp. Blatt des Vereins für wiss. Heilk., October, 1859.

Dr. Ranke[2] has made the important observation, that 20 grains of disulphate of quinine lessen very greatly (one half) the excretion (formation?) of uric acid. The experiments were made on three persons, and the results were uniform; the effect continued for about two days after a single large dose. The other constituents (water, solids, urea, chlorine, sulphuric and phosphoric acids) of the urine were unaffected.

Hammond[3] confirms the fact of the uric acid being lessened by quinine in a case of ague; the phosphoric acid and the free acidity were a little lessened, but the degree was trifling.

Böcker[4] found no alteration in any ingredient; unfortunately, however, he did not sufficiently examine the uric acid, but the observation confirms Ranke's statement that the urea is unaffected.

No explanation can at present be given of the decrease of the uric acid, but it would seem more likely that it was not simply retained, as there was no evidence, in Ranke's cases, of any increased excretion after the effect of the quinine had gone off; its formation was probably absolutely lessened, or it must have been converted into some other substance.

Reynoso has stated that quinine produces saccharine urine; but Uhle's careful experiments negative this statement.[5]

Morphia.—Morphia in part passes unchanged into the urine. The effect of morphia and opium on the water of the urine is rather variable; it often lessens it (perhaps when the action of the skin is increased), but sometimes slightly increases it. The solids appear, however, to be always decreased; in some experiments by Böcker[6] the decrease was about one eighth, and especially affected the earthy phosphates; a fact which led Böcker to the inference that the metamorphosis of bone is particularly

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[1] Dietl, Vom Uebergange des Chinins in den Harn. Wien Med. Wochensch, 1852, Nos. 47—50.

[2] Medical Times and Gazette, May 30, 1857.

In his late work (Ausscheidung der Harnsaure, p. 43), Ranke recals the opinion expressed in the Medical Times, that the phosphoric acid was increased.

[3] Amer. Journ., April, 1858.

[4] Med. Zeitung Russlands, Sept., 1859, p. 289.

[5] Op. cit., and Valentin's Report, in Canstatt's Jahresb. for 1853, p. 189.

[6] Quoted by Clarus, Handb. der spec. Arzneimitt., 1856, p. 779.

Acetate of Potash. (Experiments by the author. The results are given in ounces and grains.)

Date.	Medicine.	Time of secretion of urine, and quantity.	Solids in whole quantity.	Solids per hour.	Sulphuric acid in whole quantity.	Sulphuric acid per hour.	Remarks.
			Grains.	Grains.	Grains.	Grains.	
May 14—15	None.	8 a.m. to 8 a.m.: 24 hours=45 ounces.	584·21	24·34	21·424	0·832	
„ 15—16	None.	8 a.m. to 8 a.m.: 24 hours=36 ounces.	823·77	34·32	25·758	1·073	
„ 17—18	None.	8 a.m. to 8 a.m.: 24 hours=33 ounces.	638·99	26·62	18·873	0·786	
„ 18—19	None.	8 a.m. to 8 a.m.: 24 hours=46 ounces.	668·40	27·85	16·787	0·699	
	Mean … … … …	40 ounces.	678·84	28·28	20·735	0·862	
„ 24	At 5 p.m. 24th; Acet. Pot. ʒss; at ¼ to 12, ʒss, with water ℥iv.	12 p.m. 24th, to 8 a.m. 25th: 8 hours=18 ounces.	225·42	28·18	5·020	0·627	Urine acid at 12, neutral at 8 a.m.
„ 25—26	At 8 a.m., ½ past 10, at 5 p.m., and 12 midnight, ℈ij were taken, making ʒiij during the day, or in all ʒiv since commencement of experiment; water ℥ix with the acetate.	From 8 a.m. to 8 a.m.: 24 hours=46 ounces.	879·75	36·65	19·271	0·703	Alkaline at 12 noon.

„ 26—27	At 11 a.m., 5 p.m., and 12 midnight, 80 grains were taken, making ʒiv, with ℥vij of water, in all, or since the commencement of the experiment ℥j of Acetate of Potash.	From 8 a.m. to 8 a.m.: 24 hours=38 ounces.	641·57	26·65	18·758	0·781	Alkaline.
„ 27—28	None since 12 p.m. 26th.	8 a.m. (8 hours after discontinuance of acetate) to 8 a.m. (28th), 32 hours after leaving off the acetate: 24 hours=48 ounces.	740·58	30·85	20·952	0·864	Alkaline 13 hours after last dose of acetate.
„ 28—29	None.	8 a.m. to 8 a.m. (being from the 33d to the 57th hour after discontinuance of the acetate): 24 hours=46 ounces.	743·54	30·98	21·528	0·897	Neutral 18 hours after last dose; strongly acid 21 hours after last dose of acetate; remained acid to termination of experiment.
Mean... ... ... (Urine of 24th excluded.)		44½ ounces.	751·36	31·25	20·122	0·838	

impeded. It may, however, have merely lessened absorption from the alimentary canal. The colour of the urine deepens, perhaps from concentration in the bladder, for micturition is less frequent; sediments of urates fall, from the lessening of the water.

Morphia does not cause the appearance of any foreign ingredient. Coze,[1] who noticed that morphia increased the amount of sugar in the liver and in the arterial blood, could not detect sugar in the urine.[2]

Atropine.—The action of belladonna (and it is to be presumed of atropine) appears to be widely different from that of morphia. As is well known, it has not the astringent effects of morphia on the intestines, but even augments the intestinal discharges; and experiments by Böcker[3] prove that it increases rather than diminishes the urinary water, urea, and extractives. The fireproof salts of the uric acid were found to be slightly lessened by the same observer, but the diminution was slight, and probably immaterial. The contrary influence of morphia and atropine on the pupil is interesting in connection with the above facts.

Atropine passes off, in part at any rate, by the urine, from which it can be readily recovered (Fuller and Kesteven).[4]

Digitalin.—Digitalin, when taken in doses of 10 milligrammes a day, cannot be detected in the urine.[5] No very satisfactory evidence has yet been brought forward to prove that digitalis, or digitalin, increases the amount of urine in health. Quevenne and Homolle have collected, in their elaborate essay, all the facts hitherto known, and of these the experiments of Hutchinson[6] are the most satisfactory; in each of the series of experiments the amount of urine was greatly increased. Pereira also states that it "sometimes acts as a diuretic, even in health."[7]

Hammond,[8] from a three days' observation, gives the following amounts of the water, organic and inorganic solids, in centimeters and grammes:

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[1] Quoted by Meissner, in Henle's Zeitschrift; Report on Phys. for 1857, Band iii, p. 265.

[2] Reynoso thought he detected sugar in the urine; but if it occasionally is found, it is certainly most unfrequent.

[3] Beitrage zur Heilk., vol. ii, p. 257.

[4] Med.-Chir. Trans., 1859.

[5] Bouchardat's Archives de Phys., No. 1. Mémoire sur la digitaline, par MM. Homolle and Quevenne, Paris, 1854, p. 209. The test, however, was merely the absence of bitter taste, a mode of experimenting which would not seem accurate, but which the authors believe, in this case, to be more certain than chemical analysis.

[6] Ibid., p. 162.

[7] Materia Med., p. 1390, 3d edition.

[8] Correspondenz Blatt des Vereins für wiss. Heilk., Oct., 1859; and Proceedings of the Academy of Natural Sciences (Philadelphia).

	Water.	Spec. gravity.	Org. solids.	Inorg. solids.
Health	1474·5	1024·3	30·17	45·14
From digitalis; 60 drops daily of the American tincture	1822·8	1015·8	31·54	35·43

The several ingredients were not determined; but it would appear that the water was increased, the fixed salts lessened, the organic solids unaltered. Still, three days are not enough to give a true mean, and the amount of water taken in the ingesta was not determined.

Other authors (Krahmer, &c.) have, however, denied altogether the diuretic action in healthy persons. In diseases, and especially in dropsies, the diuretic influence would appear from many observations, particularly from those of Andral and Lemaistre, to be undoubted.[1] Christison has also noted the same fact.[2] In dogs, Siegmund noticed the urine to be slightly increased.[3] The effect on the solids is not yet known. Siegmund, in dogs, found the urea slightly decreased (from 2·612 to 2·143 grammes in twenty-four hours).

The cause of the difference in action of digitalis in health and disease may perhaps be explained by reference to its action on the heart and vessels. As well expressed by Albers,[4] digitalis "is only healing in fever, in phthisis florida, in acute dropsy;" *i. e.*, in cases in which there is rapid action of the heart to be moderated, and lateral pressure on the vessels to be controlled.

Strychnine passes off, in part at any rate, by the urine, though whether all that is taken can be recovered in this way is not known. The effect on the constituents is unknown.

Veratrin and Nicotin.—No experiments have been made on healthy men. Tobacco was praised by Fouber[5] as a diuretic in dropsies, but succeeding writers have not confirmed his statements.[6]

Colchicin; colchicum.—No experiments have yet been made with colchicin. The effects of the preparation of colchicum in health have been carefully examined by Böcker[1] and Garrod.[2] From experiments conducted in his usual careful manner on himself and on another person, Böcker found that the amount of urine was variably affected; in one case it was slightly increased, in the other greatly decreased. The urea and the uric acid were greatly lessened in both (one seventh and one fourth). The volatile salt, extractives, and earthy phosphates were also lessened. The other fixed salts were increased in one case, lessened in the other. Although Böcker does not mention the existence of diarrhœa, it is not improbable that the lessening of the urinary water may have been due to increase of the intestinal excretion. Neither Schroff nor Julius Clarus[3] was able to observe any increase in the water.

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[1] L'Union Médicale, 1851, Nos. 52 and 53. In nineteen experiments, the urine was increased in fourteen. Micturition was more frequent.

[2] Monthly Journal, 1855, January.

[3] Einwirkung des Digitalin und der Durchschneidung des Vagus auf die Harnstoffausscheidung, Virchow's Archiv, vol. vi, p. 238. Section of the vagis increased the urea; digitalis, as said above, lessened it.

[4] Handbuch der allg. Arzneimittellehre, von Dr. J. H. Albers, 1853, p. 3.

[5] Med. Report of the Effects of Tobacco, 1785.

[6] On dogs, Dr. von Praag found veratin and nicotin produce no increase of urine, except in two exceptional cases. (Veratin, Nicotin, Toxicol. Pharm. Studien, von Dr. J. L. von Praag, Virchow's Archiv, Band vii, p. 252.)

The often quoted statement of Chelius, that the uric acid is increased, appears to have been founded merely on per-centage determinations,[4] and is contradicted by Böcker's analyses.

Dr. Garrod, in a valuable paper in the 'Medico-Chirurgical Transactions' (vol. xli), communicates observations on persons who may be considered healthy; he found the quantity of urine diminished slightly, and of uric acid generally lessened. The lessening was slight, and, on the whole, colchicum would seem to have exerted little effect on uric acid in these experiments. It most certainly did not increase it. It has been stated by Krahmer that the urea is increased; this is opposed to Böcker's careful experiments.[5] Garrod noted a small increase of urea in one case.

Hammond[6] has examined the effect of colchicum for three days (1½ drachms of the tincture of the seeds daily), and has compared the amounts of water and solids with three days in health.

	Water.	Spec. gravity.	Inorg. solids.	Organ. solids.
Health . .	1280	1025·08	29·83	33·29
Colchicum .	1556	1023·58	35·23	42·04

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[1] Beitrage zur Heilkunde, vol. ii, p. 204 (1849).

[2] Papers in Med.-Chir. Trans., and his work on Gout.

[3] Handb. der spec. Arzn., 2d Aufl., 1856, p. 842.

[4] I infer this from the short abstract given in the Journal de Chimie Méd., t. iv, p. 440 (1828). I have not been able to refer to the original paper.

[5] Maclagan found the uric acid and urea increased, but he gives only the percentage amounts, and if the water happened to have been diminished in his case, the amounts of the solid ingredients would, of course, be relatively greater.

[6] Correspondenz Blatt des Vereins für wiss. Heilk., October, 1859; and Proceedings of the Philadelphia Academy, 1858.

The water, the inorganic and the organic solids, were all increased.

Three days are, however, not long enough; and it is to be regretted that the observations were not carried on for eight or ten days.

On the whole, it seems clear that colchicum rather lessens the water, perhaps from its action on the bowels—that it produces rather a lessening than an increase of urea and uric acid, (from interference with digestion?) and that its effect on the other constituents is unknown.

Squills.—Hammond,[1] from three days' observation, found the mean result of the action of squills to be:—

	Water. c.c.	Spec. gravity.	Org. solids. Grammes.	Inorg. solids. Grammes.
Health . . .	1358	1023·5	42·13	27·22
With squills (2 grains of the dried root) .	1533	1020·2	29·55	30·60

Juniper.—Hammond has given a similar series of experiments (each three days) on juniper. Sixteen ounces of the officinal (American) infusion were taken in each twenty-four hours:

	Water. c.c.	Spec. gravity.	Org. solids. Grammes.	Inorg. solids. Grammes.
Health . .	1237·5	1022·5	38·11	23·12
With juniper	1763·2	1016·28	36·42	25·03

Here, as in the experiments with squills, the time appears too short for a proper determination.

Salicin.—The metamorphoses of salicin[2] in the system have

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[1] Op. cit.

[2] The mere contact with saliva, at a temperature of 40° cent., has been found by Frerichs and Staedeler to transform salicin into saligenin and sugar (Müller's Archiv, 1856, p. 37; and Journ. für prakt. Chem., 72, p. 250). Emulsion or fermentation, in the presence of an alkali, works the same change (Ranke). The formula, according to Gregory (Turner's Chem., 8th edit., p. 848), is:

$$\overset{\text{Salicin.}}{C_{26}H_{18}O_{14}} = \overset{\text{Saligenin.}}{C_{14}H_8O_4} + \overset{\text{Sugar.}}{C_{12}H_{10}O_{10}}$$

The action of weak acids converts saligenin into saliretin by abstracting water.

$$\overset{\text{Saligenin.}}{C_{14}H_8O_4} - \overset{\text{Water.}}{2HO} = \overset{\text{Saliretin.}}{C_{14}H_6O_2}$$

If salicin be acted on at once by weak acids, saliretin is produced by successive formation of saligenin and of itself.

When stronger acids (nitric) act on saligenin, hydruret of salicyle (salicylous acid) is produced.

$$\overset{\text{Saligenin.}}{C_{14}H_8O_4} - 2H = \overset{\text{Salicylous acid.}}{C_{14}H_5O_4} + H$$

been investigated minutely by Lehmann,[1] Laveran and Millon,[2] Staedeler[3] and Ranke.[4]

When much salicin is taken, some of it passes unchanged (Ranke), the rest is decomposed and undergoes in the system, to a greater or less extent, the same changes which can be produced artificially by oxidizing agents. Saligenin and saliretin have indeed not been detected in the urine, as probably the metamorphosis has gone beyond the stage in which they are formed; but hydruret of salicyle (salicylous acid), salicylic and even phenylic acid (Staedeler), have been formed; and in all probability, the series of changes occur in the same way in as out of the body, viz., from salicin to saligenin, saliretin, salicylous, salicylic, and phenylic acid. It is probable, though it is not yet proved, that salicylic acid, thus formed, will in part combine with glycocoll and form the salicyluric acid discovered by Bertagnini (p. 148).

Salicin, therefore, takes oxygen from the body both by direct metamorphosis and also by supplying sugar, which is no doubt oxidized, and forms carbonic acid and water, as usual.

The alterations produced by salicin on the urinary constituents are not yet known. It would, *à priori*, be anticipated that as it takes oxygen, it would delay metamorphosis; but *à priori* reasonings are notoriously unsafe, though the conjecture gives the greatest interest to the investigation of this subject.

Dr. Ranke has noticed that salicin undergoes the same metamorphic changes in the diabetic as in the healthy system; another proof that it is not want of oxidating power in the system which causes diabetes, but want of capability to be oxidized on the part of the sugar.

Anilin (one of the phenyle series) cannot be detected in the urine.[5] It is, no doubt, metamorphosed in the system in the same way as salicin, but the changes have not yet been determined.

Amygdalin.—It has long been known, that (emulsin being of

Salicylous acid (hydruret of salicyle), when treated with caustic potash, takes oxygen, and forms hydrated salicylic acid, which combines with the potash.

$$\overset{\text{Salicylous acid.}}{C_{14}H_5O_4+H+2O} \quad = \quad \overset{\text{Salicylic acid.}}{C_{14}H_5O_5+HO}$$

—Salicylic acid, from still greater oxidation, will, through the formation of CO_2, form phenylic or carbolic acid.

$$\overset{\text{Salicylic acid.}}{C_{14}H_6O_6} \quad = \quad \overset{\substack{\text{Carbonic acid.}\\ \text{2 equiv.}}}{C_2O_4} \quad + \quad \overset{\text{Carbolic acid.}}{C_{12}H_6O_2}$$

[1] Wagner's Handworterbuch der Phys., Band ii, p. 15.

[2] Annal. de Chem. et phys., sér. iii, tome xii, p. 135.

[3] Annal. der Chem. und Pharm., Band lxxvii, quoted by Ranke.

[4] Phys. chem. Untersuch. Erlangen, 1851.

[5] Wöhler and Frerichs, Lieb. Annalen, Band lxv.

course not given) amygdalin does not give rise to prussic acid in the body, as it does in ordinary fermentation; the cause of this has been discovered by Ranke, who has found that amygdalin, when fermented in the presence of an alkali out of the body, produces, not hydrocyanic, but formic acid, ammonia, and a crystalline body soluble in alcohol and ether. When large quantities of amygdalin are taken, formic acid can be detected in the urine (Ranke). It does not produce hippuric acid.[1]

Mannite.—When taken into the stomach, the greater part of this substance is converted, either in the stomach or intestines, into lactic acid, and is then, probably, absorbed and destroyed in the system. About one tenth part passes unchanged, and can be detected in the urine.[2] When injected into the blood, a large portion appears in the urine (Kölliker); but a portion is, as in the intestines, converted into lactic acid and destroyed.

Glycyrrhizin passes off entirely by stool, and does not appear in the urine (Witte).

Amanita muscaria.—The intoxicating principle of this substance passes unchanged into the urine, and, as is asserted, communicates to that fluid its intoxicating properties. The effects on the urine are entirely unknown.

Copaiva.—The constituents of copaiva are, 1st, an ethereal oil ($C_{10}H_8$); 2d, a resinous acid ($C_{40}H_{32}O_4$), and a neutral resin for which there is no formula. The ethereal oil does not appear, from Weikart's late observations,[3] to pass into the urine; it is destroyed in the blood; but the resinous acid (copaivic acid), which forms 40 per cent. of the balsam, is eliminated in large amount. When nitric acid is added to urine containing this acid, a copious precipitate falls, which has been noticed by Simon and Rees, and considered to be of oily or gelatinous nature. It is, according to Weikart, chiefly copaivic acid, which is separated by the nitric acid from the soda or potash with which it was in combination, and which falls in association with urates and uric acid.

The effect of the copaivic acid on the urinary mucous membrane is, according to Weikart, attributable to its action on the fatty acids contained in pus-cells formed by the inflamed membrane; the cells become shrivelled, and their nutrition and growth are arrested.

Senega.—Infusion of senega (4 to 6 drachms infused in 6 to

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[1] Wöhler and Frerichs, Lieb. Annalen, Band lxv, p. 335.

[2] Witte, in Meissner's Report on Phys. for 1856; Henle's Zeitsch. für rat. Med., 1857, p. 273; and Valentin's Report for 1856, C. J., Band i, p. 110.

[3] Archiv fur Heilkunde, Band i, 1860, p. 176. The copaivic acid is, according to Weikart, the sole active agent. It can be separated from the oil and resin, and given in pills.

12 ounces of water, and taken during the day) produced no effect in Böcker's experiments, conducted on himself and on a pregnant woman.[1]

Cumarin (obtained from the Tonka bean) passes unchanged through the body, and does not give rise to hippuric or benzoic acid.[2]

Santonin ($C_{30}H_{15}O_6$) passes off rapidly in the urine,[3] giving it an orange-yellow colour; even in small quantities, it may be detected by the deep-red colour given by the addition of ammonia. The last trace disappeared from the urine in about twenty hours. Various conjectures have been made as to the exact nature of the pigment, and the changes in the santonin. According to Martin, chrysophanic acid is produced, which makes the serum of the blood yellow, and is then excreted in the urine,[4] but it seems doubtful whether chrysophanic acid can have this effect.

Chlorophyll, in dogs, produced no hippuric acid (Hallwachs).

Creosote may perhaps give rise to carbolic acid, like tar, as a dark colour of the urine is sometimes noticed after its use. This was first observed by M'Leod ('Med. Gazette,' 1834-5), and was also pointed out by Elliotson ('Med.-Chir. Trans.,' vol. ix). Lately, it has been fully indicated by Hughes (Guy's Hospital Report, 1856, p. 52). Kletzinsky[5] states, that it increases the amount of indigo blue.

Vegetable oils and colouring-matter.—Various essential oils, as of *juniper, valerian,* and *garlic,* in part pass into the urine, to which they give their peculiar odour. Whether they are destroyed to any extent in the body is not known, nor have their effects on the urinary excretion been determined.

Turpentine gives a violet odour to the urine. Its effect on the urinary constituents is unknown. By its action on the kidneys, it may cause hæmaturia and albuminuria.

Castor oil alters the urine only by its purgative action; the amount of water is reduced, and the chloride of sodium and sulphuric acid are somewhat lessened (author). The effect on the urea, uric acid, and extractives, is not known.

Vegetable colouring-matters.—Senna gives a yellowish colour, deepened by alkalies. *Rhubarb* also gives a yellow colour to the urine, which is more or less deep, according to the feeble acidity or alkalinity of the urine. Liquor potassæ changes this into red, and an amaranth-coloured precipitate is given by acetate of lead. Schlossberger[1] states, that of the various constituents of rhubarb, it is the phaeoretin and the erythroretin which give this colour. The chrysophanic acid does not alter the colour of the urine. *Gamboge*, when taken in large quantities, also gives a yellow colour. The greatest effect in this way is, however, produced by *santonin*, as already noticed.

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[1] Beitrage zur Heilk., 1849.

[2] Hallwachs, in Meissner's Report on Phys. for 1857; Henle's Zeitsch., p. 315.

[3] Kletzinsky, Heller's Archiv, Neue Folge, 1852.

[4] Martin, in Schmidt's Jahrb., 1856, June, p. 293. See also Grimm, Ueber Santonin vergiftung Schweiger Zeitsch., 1852, Heft ii.

[5] Schmidt's Jahrb., 1859, No. 10, p. 36.

Some vegetable colouring-matters do not pass into the urine; thus, Kletzinsky[2] could not detect the pigments of *saffron, logwood, madder, alkana, guaiacum, or aloes.*

According to the same author, indigo does not pass into the urine; but Ranke has satisfactorily proved that it does do so. The statements of some older writers[3] are thus confirmed.

Vegetable odorous substances, such as assafœtida, garlic, and valerian, give, in some cases, their odour to the urine.

11. *Animal Substances.*

Cod-liver oil.—As fatty substances in general lessen the excretion of nitrogen under certain conditions, (see p. 59,) and in this way restrain disintegration, it might reasonably be inferred that cod-liver oil has a similar action. This has been experimentally examined by Beneke,[4] who found the quantity of urea and uric acid generally lessened. It is undoubted that persons who take the oil gain weight without additional food. Whether this is owing to direct accumulation of the fat, or to the oil becoming oxidized and sparing the nitrogenous tissues, or whether it aids formation by direct union with albuminous substances, which otherwise would be broken up and eliminated, is not yet known; but the latter hypothesis is the favorite one at present. According to Beneke, cod-liver oil invariably lessens the free acidity of the urine; an action ascribed by this observer to the lessened disintegration of the nitrogenous issues.

The effect on the other urinary constituents is unknown.

Urea.—Gallois[5] found that urea given to rabbits commenced to pass off in from thirty to forty minutes; it ceased to be detectable in from sixty to seventy hours.

Guanin.—Kerner[6] has noticed that, in rabbits, guanin increases the quantity of urea. No other change occurred, and the guanin was probably converted simply into urea and carbonic acid in the organism. All the guanin did not appear as urea; some passed off with the fæces.

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[1] Archiv für phys. Heilk., 1848, p. 210.

[2] Ueber der Uebergang von Farbstoffe in der Harn., Heller's Archiv, N. F., vol. i, pp. 46, 133, 338.

[3] See Rayer, Mal. des Reins, t. i, p. 68.

[4] Zur phys. und path. des phophorsauren und oxalsauren Halkes. Gott., 1850, p. 91.

[5] Gazette Médicale de Paris, 1857, p. 258.

[6] Meissner's Report, in Henle's Zeits. for 1857, p. 313.

Taurin, when taken in doses of 10 grammes (154 grains) in eight hours, was not found in the urine (Schottin).

Cantharides.—In medicinal doses, cantharides produces no constant effect on the quantity of urine; sometimes it increases, sometimes decreases it.[1] Its effect on the other constituents is not known. According to Siegmund,[2] it increases the amount of urea in animals.

In larger doses, cantharides act as an irritant on the kidneys, and produce scanty and sometimes bloody urine, with or without strangury.

Glycocoll (glycin) is destroyed in the system, and does not appear in the urine. According to Horsford,[3] it increases the amount of urea and uric acid.

Alloxantin is also destroyed in the body; the amount of urea is increased, in proportion to the amount of alloxantin (?).

SECTION IV.

SURGICAL APPLIANCES—OPERATIONS.

Müller[4] has examined the amount of urea before and after operations in seven cases;[5] the weight of the body was always determined, and the amount of urea excreted by each kilogramme was calculated. The general rule was, that at first (owing to the loss of substance from the operation?) the urea lessened, but on the second day increased again, from increased disinte-

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[1] Pereira, Materia Medica, 3d edition, 1853, p. 2207.

[2] De ureæ excretione nonnulla, experimentis illustrata. Berol., 1853.

[3] Lehmann, Phys. Chem., Band i, p. 158.

[4] Quoted in Schmidt's Jahrb., 1859, No. 10, p. 16.

[5] Of the seven cases, however, three were of slight operations (extraction of tumours, &c.); and of the four others, one died on the second day, another on the eleventh from pyæmia, and a third had erysipelas. The modifying circumstances were thus considerable.

The analyses in the pyæmic patient are interesting. The operation was for epithelial cancer of the tongue. The man was aged fifty-eight, weighed 59·54 kilogration and pyrexia (measured by thermometer), or sometimes without pyrexia. After a longer time, the urea returned to its normal amount, or fell a little below this.

grammes (131 lbs.) before the operation, and only 50·12 kilogrammes (110 lbs.) on the day of his death.

Before the operation, the 24 hours' excretion of urea to each kilogramme was 0·442 grammes (= 3·1 to each pound avoirdupois).

During the first four days before pyæmic symptoms, the daily excretion of urea was to each kilogramme—

On the first day	0·468 grammes.
„ second „	0·600 „
„ third „	0·806 „
„ fourth „	0·790 „
The mean of the seven last days during which there were pyæmic symptoms was, to each kilogramme	0·607 „
	(= 4·26 grains to 1 lb.)

The enormous formation of urea soon after the operation is well seen, and the intense pyrexia it indicated might, perhaps, have led to an anticipation of the subsequent pyæmia. The temperature rose from 101° Fah. on the evening of the operation, to 105·6 on the seventh day—its highest point.

BOOK II.

ON THE

COMPOSITION OF THE URINE

IN

DISEASE.

INTRODUCTION.

ENUMERATION OF THE ABNORMAL CONSTITUENTS OF THE URINE AND OF THE URINARY SEDIMENTS.

As the enumeration of the normal constituents naturally preceded the First Book, which refers to physiological alterations in the urine, so a brief enumeration of the abnormal constituents will appropriately occupy the Introduction to the Second Book, which treats of the Urine in Disease. But as in the first Introduction, so also in this place, I have passed over this subject as concisely as possible, as it is treated of in other works.

I have also included the urinary sediments,[1] for the sake of convenience, though some of them are composed of normal constituents of the urine. If not abnormal in point of composition, they are all abnormal in point of place, as in perfectly healthy urine there is no sediment whatever, unless it be the very merest haze of mucus, or the slight precipitate of urates caused by a low temperature. Perhaps even this is abnormal.

SECTION I.

SUBSTANCES DISSOLVED IN THE URINE, OR PRECIPITATING ONLY UNDER SPECIAL CONDITIONS.

1. *Hæmatin,* or *blood-pigment.*—Hæmatin appears in the urine in two states, either in the blood-corpuscles or separate from these. In the first case, the blood forms a sediment, and

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[1] I have omitted the consideration of calculi. The causes leading to calculi are, in many cases, the same as those producing sediments, but the subject requires separate treatment.

will be noticed hereafter; in the second, the pigment is completely dissolved in the urine, to which it gives a more or less brown or black colour. Dissolved hæmatin appears to indicate, not local disease and rupture of vessels, but a special affection of the blood, either general or local, produced by most septic or profound cachectic diseases.[1] In bad typhus, malignant variola, pernicious remittents, &c., in scurvy, and sometimes in morbus Brightii, the urine may be very dark from hæmatin; and the very dark urines, if bile and vegetable pigments be absent, almost always indicate its presence. The rare cases of Melanin would be the only exceptions. Albumen is always also present (Heller, Hoppe).

2. *Albumen.*—Albumen in the urine must, probably, be considered always pathological, but sometimes it occurs temporarily and in small quantity in the case of persons who are called healthy. Articles of diet which are difficult of digestion are said by Christison[2] to cause it for the time; and he refers to the case of a student, in whom a large amount of cheese or pastry always produced albuminuria. But as this gentleman died two years afterwards from morbus Brightii, his kidneys may not have been altogether sound. Owen Rees has never known cheese, milk, or pastry, cause temporary albuminuria.[3] Becquerel[4] mentions, however, that, after taking ten eggs, Barreswil passed albuminous urine for twenty-four hours. Hammond, also, noticed that his urine became albuminous when he was solely on egg diet. Similar facts have, according to Hammond, been observed by Mialhe and Brown-Séquard.

Apart from errors of diet, however, temporary albuminuria will occur in persons with very slight disease. Beneke,[5] when suffering from dyspepsia, noticed albumen in his own urine four times in four weeks; this was ten years ago, and he has had no symptoms of kidney or other disease. Clemens[6] has confirmed this statement, and similar assertions have been made by Rayer and Solon.[7] Solon, in six hundred cases, noticed one of temporary albuminuria in health. Usually, however, there is no doubt that some marked pathological condition exists, either in the kidneys or in other parts. The following tables, taken from various works, show the diseases in which albuminuria may occur.

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[1] The bile acids are said, by Kuhne, to have a powerful dissolving effect on the blood-cells. May some of the cases of hæmatin in the urine be owing to an action of this kind in febrile icterus?

[2] Monthly Journal, Jan., 1851.

[3] Medical Times and Gazette, July, 1851.

[4] L'Union Méd., 1857, No. 155.

[5] Archiv des Vereins für wiss Heilk., Band i.

[6] Deutsche Klinik, 1851, No. 22.

[7] See also Balfour on the Diagnostic Value of Albumen in the Urine, Edinb. Med. Journal, 1855, p. 606.

From Martin Solon's[1] cases the following table has been compiled:

Disease.	No. of cases.	Urine albuminous in
Intermittent fever	8	2[2]
Typhoid fever	23	4
Rubeola	7	1
Variola	8	1
Pleuro-pneumonia	22	2
Scarlatina	3	1

Finger[3] compiled the following tables from the cases in Oppolzer's wards at Vienna:

Disease.	No. of cases.	Albuminous in
Tuberculosis pulmonum ...	186	46
Typhus (abdominalis ?) ...	88	29
Puerperal fever	46	32
Intermittent fever	10	1
Pneumonia	33	15
Bronchitis	16	3
Pleurisy	14	2
Peritonitis	6	2
Intestinal catarrh	65	8
Acute rheumatism	16	2
Chlorosis	6	2
Disease of heart	18	7

Of the forty-six cases of albuminuria in phthisis, thirty-five died. It is stated that only two had kidney disease. Of the other albuminous cases, thirty-two died; and it is affirmed that in not one of these was there kidney disease! It must be said, however, that this table was constructed before the microscopical characters of diseased kidneys were so well understood as they have been since the researches of Johnson, Gairdner, Simon, Frerichs, and others.

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[1] De l'Albuminurie, Paris, 1838.

[2] Some writers quote Martin Solon as stating that the urine was albuminous in seven of eight cases of ague, but this is wrong. Solon found it coagulable by heat in two cases; but in five others it formed a precipitate from a drop of acid, but no coagulation by heat. This precipitate, which he calls "urine critique," is merely a precipitate of urates and uric acid.

[3] Quoted by Eisenmann, in the Würzburg Verhandl., Band iii, p. 190.

A table of a different kind has been contributed by Heywood Thomson.[1] In seventy-five cases of albuminous urine, he determined the presence of the following diseases:

Disease.	No. of cases.	Blood also present.
Morbus Brightii	10	...
Scarlatina	25	25
Rheumatism	2	2
Arthritis	1	1
Typhus (2d week)	1	1
Nephritis (calculous ?) ...	1	1
Catarrh...	3	2
Pneumonia	2	2
Erysipelas	1	1
Torpor hepatis...	3	3
Peritonitis	1	1
Phthisis	4	...
Chlorosis	4	2
Oxaluria (intense)	4	3
Phosphatic diathesis	3	3
Pregnancy (last month) ...	2	2
Uterine disease	5	5
Bladder cancer...	1	1
Internal use of turpentine ...	2	2
Total	75	57

It is very noticeable here, that in so many cases there was hæmaturia as well as albuminuria.

In order to test the accuracy of these statements, and especially to draw a stronger distinction between temporary and permanent albuminuria, I lately analysed those cases of my adult patients in University College Hospital in which the urine was examined carefully and daily for a sufficient length of time to enabled it to be said, with perfect accuracy, that albumen was or was not present during the whole course of the disease, or at any time of it. Cases of cystitis and vaginitis were not included. I give the results as a small contribution to this important subject. By the term "temporary albuminuria" I imply a case in which, after lasting for some days or even weeks, the albumen entirely disappeared for some time before the patient left the hospital: and by "permanent albuminuria," a case in which the albumen did not disappear during the time the patient was under observation; this time being generally very long, and always many days. University College Hospital is a general hospital, into which cases of small-pox and scarlatina are seldom admitted. I have excluded from consideration all cases of cholera and of pregnancy.

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[1] Lancet, July, 1857.

Table I.[1]

	Total number of cases.	Urine not albuminous at any time.	Urine temporarily albuminous.	Urine permanently albuminous.
Men	170	124	21	25
Women ...	133	103	16	14

Reduced to a per-centage, this table is as follows:

In every 100 men admitted into the medical ward of a general hospital in London	72·94	12·35	14·71
In every 100 women admitted into a general hospital in London	77·44	12·03	10·53

The proportion of cases of temporary albuminuria is therefore almost the same in the two sexes; *i. e.* the causes producing the albumen are independent of sex. The proportion of cases of permanent albuminuria is greater by rather more than 4 per cent. in males, on account of the greater prevalence of organic kidney disease in male hospital patients in London.

The per-centage is considerably greater than that given by Dr. Barlow, who found, from an investigation of 300 sick persons, that 9 per cent. had albuminuria.

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[1] These tables were published in the Medical Times and Gazette, Jan., 1859.

(*a*) *Temporary albuminuria.*—The diseases, in the course of which the temporary albuminuria appeared, were—

Table II.

Disease.	Men.			Women.		
	Total number of cases.	Temporary albuminuria.	No albuminuria.	Total number of cases.	Temporary albuminuria.	No albuminuria.
Paraplegia (spinal)	...	...	...	2	1	1
Hemiplegia (cerebral hæm.) ...	3	1	2	1	1	...
Phthisis (chronic)	17	1	16	11	...	11
Pleurisy (acute)	11	1	10	6	...	6
Bronchitis (acute), lungs otherwise healthy	3	1	2	3	...	3
Bronchitis (acute in emphysematous lungs...	6	1	5	3	1	2
Bronchitis (tuberculous lungs)...	...	...	...	1	1	...
Pneumonia (acute lobar) ...	7	3	4	3	3	...
Heart disease, hypertrophy, dilatation, and valvular affections	6	1	5	11	1	10
Acute morbus Brightii... ...	3	3	...	...	...	...
Acute rheumatism	8	2	6	11	2	9
Subacute rheumatism	8	1	7	...	...	...
Purpura hæm.	...	...	...	1	1	...
Typhoid fever	10	2	8	9	3	6
Typhus	2	1	1	...	...	...
Variola	2	1	1	3	1	2
Scarlatina	1	1	...	1	1	. .
Erysipelas (leg)	1	1	...	...	...	...
Total...	88	21	67	66	16	50
Per-centage	...	23·86	76·14	...	24·24	75·76

The per-centage of this table (which includes all the diseases any case of which had the urine temporarily albuminous) shows, as in Table I, that the effect of sex is not obvious in the production of this symptom.

The quantity of albumen was large in the pneumonic and acute renal cases; was in some quantity in the typhoid, variolous, and scarlatinal cases; was very small in most of the rest. Blood on microscopic examination was observed only in three cases, in which the amount of albumen was small; but it may have been present in some others.

(*b*) *Permanent albuminuria.*—The causes of the permanent albuminuria were—

Table III.

Disease.	Men. Albuminuria.	Women. Albuminuria.	Remarks.
Morbus Brightii (all forms) ...	16	9	
Encephaloid disease of kidney ...	1	...	
Cystic disease of kidney	1	...	
Leucocythemia with presumed lardaceous kidney disease ...	...	1	
Chronic phthisis and kidney disease on p.-m. examination	1	...	
Pleurisy with probable kidney disease	1	...	Casts and kidneys structures in sediment of urine.
Heart disease (hypertrophy and valve affection)	2	2	Kidneys healthy in 3 cases on p.-m. examination.
Hemiplegia from cerebral softening	...	1	Blood-corpuscles.
Pancreatic disease causing icterus	1	...	Amount of albumen very small.
Purpura hæm.	1	...	Case not fatal; nothing definite known about kidneys.
Typhoid fever	1	1	Blood, casts, and establishment of decided morbus Brightii consecutive to the fever.
	25	14	

Therefore in thirty-two out of thirty-nine cases of permanent albuminuria, disease of the kidneys was either proved, or was rendered highly probable, by the presence of other symptoms. In three other cases kidney disease was not disproved; but as nothing was decidedly known, I believe I am justified in excluding them from further consideration.

Permanent albuminuria indicated, then, kidney disease in thirty-two out of thirty-six cases; and if the heart diseases be excluded, it may be said that it indicated kidney disease invariably. Of late years the discovery of albuminuria in so many diseases has caused some scepticism as to the value of this symptom, but it would seem that the distinction of temporary and permanent albuminuria has not been drawn with sufficient care, and that if it be permanent, the significance of albuminuria is as great as it was supposed to be by the older writers on morbus Brightii.

In all these diseases we must assume that there is either congestion, and increased lateral pressure on the vessels, or absolute structural disease of their walls. If, indeed, as has been surmised, albumen under normal circumstances transudes from the glomeruli, and is afterwards reabsorbed by the epithelium and by the vessels encircling the tubes, it might arise from a loss of epithelium or absorbing power. But as this hypothesis, though supported by great names, is not generally received, it cannot be at present used as an explanation.

That the diffusive power of serum-albumen, usually so very small, may be increased so that the albumen permeates vessels which usually it cannot pass, is a possible hypothesis, to which reference will be made under the head of "Morbus Brightii."[1]

Great hydræmia does not appear to cause albuminuria without the simultaneous transudation of hæmatin.

In purpura hæmorrhagica, albumen sometimes passes without blood.

In addition to affections of the kidneys, albumen appears in the urine in bladder diseases (cystitis), in abscess in the prostate or vesiculæ seminales, or along the course of the urethra. It is then proportioned to the pus or blood present.[2]

The mixture of spermatic fluid also causes it.[3]

A varicose condition of the lymphatics has been supposed to cause albumen, with other substances, to appear in the urine in the singular hæmaturia which is seen in the Mauritius and in Bourbon.

3. *Modified albumen—Albuminose—Peptone.*—In some cases the albumen in the urine does not exhibit its usual reaction, and it has therefore been supposed to be in a modified condition. Thus often, while heat and nitric acid together cause a copious precipitate, nitric acid in the cold produces no coagulation; and on the other hand, it was noticed by Prout, that acid albuminous urine in some cases (especially in chylous urine) coagulates by nitric acid, but not by heat. He thought the albumen "hydrated," or "imperfect." Bence Jones[4] and Beneke[5] have also noticed these reactions. The first reaction is not un-

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[1] When Valentin coated the skin of rabbits with varnish or albumen, the urine became albuminous (Archiv für phys. Heilk., 1858, p. 486). Was this from kidney congestion, or from some altered condition of the albumen?

[2] For a summary of the whole subject of Albuminuria, see an able review by Dr. Warburton Begbie, in the Brit. and Foreign Med.-Chir. Rev. for 1854.

[3] This has been doubted. Bence Jones, however, has set the question at rest (Animal Chemistry, 1850, p. 108).

[4] Animal Chemistry, 1850, p. 103.

[5] Archiv des Vereins für wiss. Heilk., Band i, p. 467.

common; the second is more so, and I have never myself seen it in acid urine.

The effect of alcohol and heat on albuminous urine is also variable; sometimes the coagulation is complete; in other cases a gelatinous-like compound is formed, which dissolves again.

A peculiar albuminous substance was discovered by Dr. Bence Jones in the urine of a patient with mollities ossium.[1] When nitric acid was added to the urine of this patient, no change was at first produced; on standing, the urine became solid; it liquefied by heat. Hydrochloric acid acted in the same way as nitric. Acetic acid gave a slight precipitate, soluble by heat.

It had not, however, always the same reaction; on one occasion the urine did coagulate on heat. This substance was in twice as large a quantity as the urea; its ultimate composition was $C_{48}H_{38}N_6O_{18}$. It contained 1·03 per cent. of sulphur, and 0·19 per cent. of phosphorus.[2]

Mialhe,[3] who distinguishes between albumen, albuminose (*i. e.*, digested albumen, which is not precipitated by heat and acids, is highly diffusible (Funke), and can pass through membranes—the peptone of Lehmann), and modified albumen (viz., a transition form between albumen and albuminose, precipitated by heat and acids, but dissolved by nitric acid in excess), asserts that any one of these substances may appear in the urine; exact investigations are, however, still wanting.

4. *Casein.*—This substance has been supposed to be present in the so-called chylous urine, but this has not been proved with sufficient accuracy. It has also been said, without adequate proof, to be present in the "kiestein" of the urine of pregnant women. At present casein has not been satisfactorily shown to be present in any case.

5. *Leucin* ($C_{12}H_{13}NO_4$) has been found in the urine, by Frerichs, in a case of typhus (typhoid?); in cases of the acute yellow atrophy of the liver (Frerichs and Scherer), and in variola. Thudichum[4] discovered it in the urine of a man, whose liver yielded a large quantity. The nature of the disease is not stated.

As leucin exists normally in the spleen (lienin of Scherer), and in the liver (Liebig and Gorup-Besanez), and in the pancreas (Frerichs and Virchow), the thymus gland, and other parts, its appearance in the urine may possibly be connected with disease of any of these organs; but at present it seems to be chiefly furnished by diseased livers, as it has been found by Frerichs and Neukomm in large quantities in the liver in acute yellow atrophy, typhus, variola, rheumatic fever, and tuberculosis; and it is in the first three diseases that it has been detected in the urine. Neukomm looks upon it as the product of the too rapid destruction of the elementary nitrogenous tissues of a part—a process which goes on more markedly in the liver, in the acute yellow atrophy, and perhaps in variola and in typhus, than in any other disease. At present, however, the true value cannot be assigned to the appearance of leucin in the urine.

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[1] Phil. Trans., 1848, p. 55.

[2] As Bence Jones regards the formula of protein as $C_{48}H_{37}N_6O_5$, he considers this substance to be an hydrated deutoxide of protein.

[3] L'Union Médicale, 1852, Nos. 80—90.

[4] Pathol. of Urine, p. 280.

6. *Tyrosin* ($C_{18}H_{11}NO_6$) generally accompanies leucin, both in diseased livers and in the urine. It has been found in typhus, variola, and acute yellow atrophy of the liver. (Frerichs, Staedeler, and others.) Its pathological importance is probably the same as that of leucin.[1]

7. *Xanthin* ($C_{10}H_4N_4O_4$), a substance closely connected with uric acid, occurs in muscle, liver, spleen, blood, and other parts (Scherer). It may, perhaps, be a normal constituent of the urine, and is certainly common in disease. It forms one rare kind of calculus. It is evidently closely connected with uric acid, and still more so with hypoxanthin. It is, probably, of great pathological importance, but this is a subject on which the future must teach us.

8. *Hypoxanthin* ($C_{10}H_4N_4O_2$) (or sarkine) is a lower oxidized product than xanthin or uric acid; it has been found in the urine of leucocythemia, and in other cases, by Scherer. It invariably accompanies xanthin in the organs and in urine.

9. *Cystin* ($C_{12}H_{12}N_2S_4O_8$) occurs both in the form of calculus, and as a sediment, or dissolved. [For full particulars see chapter on "Chronic Diseases."]

10. *Taurin* ($C_4H_7NS_2O_6$) has been found in the urine of icterus, and is no doubt derived from the decomposed bile acids of the liver.[2]

11. *Sugar.*—Grape sugar, or glucose ($C_{12}H_{12}O_{12}$), is found in the urine in diabetes mellitus, and in much smaller quantities and much less permanently in several other diseases, and even in healthy persons who have taken a large quantity of sugar or of substances easily changed into it. The causes of the temporary

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[1] Hoppe (Anleitung zur path.-chem. Anal., 1858, p. 197) has never yet found tyrosin in the urine. For the mode of detection of leucin, tyrosin, xanthin, and hypoxanthin, I beg to refer to Scherer, or to Lehmann's Handbuch (3d edit., 1859).

[2] Allantoin ($C_8H_6N_4O_8$) has been discovered by Frerichs and Staedeler in the urine of a dog, into whose lungs they injected oil, and in another case in which a dog was made to inhale chlorine. Köhler (Schmidt's Jahrb., 1859, No. 10, p. 31) also obtained allantoin from the urine of rabbits, into whose lungs oil was thrown. But none of these observers could find it in the urine of men, even during the most violent dyspnœa. It probably occurs in the urine of young children, but is in that case not abnormal.

Guanin, sarkosin, and kynurenic acid (acid of the urine of dogs), have been conjectured to occur in human urine, but no satisfactory evidence has been brought forward.

appearance of sugar are extremely obscure, but it is supposed to occur from impeded oxidation. It occurs after some injuries to the head,[1] probably from irritation about the medulla and fourth ventricle, increasing the sugar-formation in the liver. Various operations on the spine can also cause it in animals (Moos and Schiff).

It has been stated to occur in all cases in which respiration is greatly impeded, in emphysema, pertussis (Gibb), after epileptic and hysterical fits, or narcotism from chloroform, from fits of anger (Bernard, in one case), in old persons,[2] and in dogs after mercury, iron, quinine, antimony, and arsenic had been given. In men treated with carbonate of iron, Reynoso found the urea always saccharine.[3] These statements are in many respects doubtful, and some have been denied by good observers, as for example, by Beale (in the paper referred to below), or by others.[4] Uhle (an observer well known for his careful observations on sugar in the human body) could find no sugar in the urine, of two epileptics, of an hysterical patient, of narcotized men and guinea-pigs, of two cases of pneumonia, of three of emphysema with great dyspnœa, of two of tuberculous lung infiltration, of one of rather copious pleuritic effusion, or of men who had taken sulphate of quinine, mercury, or narcotics.[5]

Frerichs and Städeler could detect no sugar in the urine of men labouring under the intensest dyspnœa, nor in the urine of dogs into whose lungs oil had been injected.[6]

At present the question remains thus undecided; it is clear, however, that the amount of sugar in any of these cases, if it exist, must be small.

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[1] Szokalski, in Canstatt's Jahresberichte. Report of Vogel on Chronic Diseases, p. 195. The patient was not known to have had diabetes. Sugar was found after the fracture, and disappeared on cure. Several cases (nineteen or twenty) are now on record, and have chiefly been collected by Griesinger (Archiv für phys. Heilk., 1859). See also a case by Murray in the Lancet for June, 1860.

[2] Reynoso, Dechambre, &c. See British and Foreign Medico-Chirurgical Review, January, 1853, p. 106, where the observations of these writers are very ably reviewed by Dr. Beale.

[3] Comptes Rendus de l'Acad., Nov. 1851. The urine was precipitated with diacetate of lead, filtered, and the excess of lead got rid of; the clear fluid was then concentrated, and the copper and yeast tests employed. Boedeker (Henle's Zeitschrift, 1859, Band vii, p. 130) has described a substance in the urine of a man with an obscure cerebral and spinal disease, which reduced the copper solution, and combined with potash like sugar. As the alkaline solution eagerly absorbed oxygen, he called it "alcapton" (from the Arabic *alkali*, and the Greek *κάπτειν*, to swallow eagerly). Sugar, in cold alkaline solution, absorbs oxygen very slowly. The alcapton did not ferment. It contained CHNO, but elementary analysis could not be undertaken. The observation at present is unique and imperfect.

[4] The extraordinary difficulties of detecting small quantities of sugar, and the numerous fallacies attending *all* the tests, render a re-examination of this whole subject desirable. See Lehmann's admirable critique in Schmidt's Jahrb., 1858, No. 1.

[5] Experimenta de saccharo in urinam aliquamdiu transeunte (Diss. Inaug., Leipsic, 1852). I must say that I have great doubts respecting all Reynoso's statements. When he wrote, the many fallacies of the sugar test were not well understood.

[6] Müller's Archiv der Anat., 1851, p. 393.

12. *Inosite* ($C_{12}H_{12}O_{12}+4HO$).—Inosite has now been found in many parts of the body in addition to muscle, for example, in the lungs, the kidneys, the spleen, and the liver. In all probability, it occurs often in the urine, but it has as yet only been found in the urine of a woman with morbus Brightii (Cloetta),[1] and in diabetes mellitus (Voit).[2] In this last case it replaced the usual diabetic sugar. Neukomm has also discovered it in the urine of morbus Brightii and in diabetes.[3]

13. *Aceton* ($C_6H_6O_2$).—Petters[4] obtained this body by distilling the urine, in a case of diabetes mellitus, and in one of measles. It was probably merely a product of the distillation.

14. *Fat.*—When fat passes into the urine, it is sometimes in particles large enough to be recognised with the unassisted eye or with the microscope. (See "Sediments," p. 209.) Occasionally it is too finely divided to be thus seen. Sometimes it is entirely dissolved, and exists as oleates and stearates. In morbus Brightii it occurs in this last form very frequently, in small amount.[5] Cholesterine has been obtained from the urine by Gmelin[6] in a case of jaundice, and by Beale[7] in cases of morbus Brightii.[8]

15. *Bile pigments.*—Even in healthy persons, small quantities of bile pigment will appear in the urine in hot weather.[9] It occurs also as a transient condition, when there is no jaundice of the skin; but it is, of course, most marked in jaundice.

Both modifications of the bile pigment, the brown and the green (cholepyrrhin and biliverdin), occur in the urine; the latter (the derivative of the former) being the most common, and often occurring alone.

16. *Bile acids.*—The bile acids (taurocholic and glycocholic acids) appear in the urine, both with and without bile pigment. They are not necessarily present in icterus,[10] as they may be destroyed in the blood as in the normal condition, whereas the

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[1] Cloetta, quoted by Neubauer, 3d edit., p. 68.

[2] Voit, Archiv für phys. Heilk., 1858, p. 411.

[3] Schmidt's Jahrb., 1860, No. 1, p. 6.

[4] Prag. Vierteljahrb., vol. lv, p. 81; and Meissner's Report on Phys., in Heule's Zeits., 1857, p. 310.

[5] See, among others, Kletzinsky, in Heller's Archiv für pathol. Chem., N. F., 1852, p. 288.

[6] Simon's Chemistry of Man, by Day, vol. ii.

[7] Beale's Archives of Med., vol. i, p. 8.

[8] Neubauer states (Anleitung, 3d edit., p. 77) that cholesterine has not been found in urine. Gmelin, Möller, and Beale's observations do not appear to be known to him.

[9] Scherer, quoted by Vogel, in Neubauer's Anleitung, 2d edition, p. 190.

[10] See "Icterus" for some remarks on this point.

pigment cannot be so got rid off, or, if Frerichs be correct, they may be transformed into pigment; according to Pettenkoffer, they are found sometimes in the urine of pneumonia, and Frerichs has noted them in the urine of the acute yellow atrophy of the liver.

Dyslysin is also found in the urine, as a derivative from the above.

17. *Acetic acid* has been supposed to be found in some diseases, as in rheumatic fever (Henry).

18. *Lactic acid* ($C_{12}H_{10}O_{10}+2HO$).—This acid occurs in many specimens of fresh urine, and it is also supposed to form rapidly after emission of the urine, from fermentation of the pigment. According to Lehmann, lactic acid occurs generally when large quantities of oxalate of lime and of uric acid are also present. It is not yet known whether it is abundant or even present in the urine of rheumatic fever. On the whole, the present doctrine appears to be, that lactic acid indicates deficient oxidation, and that oxalic and uric acids are co-products with it of an impeded metamorphosis.

19. *Butyric* ($C_8H_8O_4$) and *valerianic acids* ($C_{10}H_{10}O_4$) have been found frequently in morbid urine, but the precise causes of their appearance are not known. The late researches of Neubauer on the metamorphoses of leucin indicate that these acids are derived from it.[1] Butyric acid forms after emission in diabetic urine.

Formic acid ($C_2H_2O_4$) has been noticed by Campbell in the urine of phthisis, but, as already noticed, it may sometimes be a constituent of normal urine.

Metacetonic acid ($C_6H_6O_4$) has as yet been found only as a product of changes occurring after emission.

20. *Nitric acid* was indicated by Prout, but as the observation has not been confirmed, it has been conjectured that the reagents used (barytic water) were not perfectly pure. Dr. Prout, however, expressly states that the barytic water he used was pure, and it may be considered doubtful whether nitric acid is not really sometimes present.

As already stated, Dr. Bence Jones believes that ammonia taken as medicine is converted into nitric acid, but this point is still undecided.

21. *Sulphuretted hydrogen* is occasionally found in the urine when first passed. Generally it is, however, in diseases with some torpor of the bladder, and probably decomposition of sulphur compounds has taken place in the bladder.

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[1] Liebig's Annalen, Band cvi, p. 59. The simplest decomposition of leucin is into ammonia, oxalic acid, and valerianic acid. Valerianic acid breaks down into butyric, metacetonic, acetic, and oxalic acids. The metamorphosis of leucin may, perhaps, cause the appearance of all those acids in the body and excretions.

22. *Abnormal Pigments.*—I have included under this head some pigments which, perhaps, may be present in healthy urine, and which may have therefore no right to the title of abnormal. At the same time, as there is some doubt of this, it seems more advisable at present to place them under this heading.

Owing to the great difficulty of isolating these pigments, their study was for many years in a state of extreme confusion; and even now, it is questionable whether the subject is wholly understood.

Uroxanthin—Indican.—It is but common justice to state, that Heller, of Vienna, has for many years affirmed, that there exists in many urines (both normal[1] and morbid) a substance, itself colourless, or nearly so, which gives rise by internal changes to several pigments; this substance he termed uroxanthin.[2] The urine in which it occurs is often poor in normal pigment, is generally pale yellow in colour, and is very acid. Virchow has pointed out that it is especially in urine rich in this substance that the so-called "acid fermentation" (the rapid development of acid (lactic?)) occurs after emission, and by which increased acidity, uric acid is often precipitated. The occurrence of uroxanthin is easily known by the action of strong hydrochloric or nitric acid, which gives the urine a deep purple, or violet, or blue colour, and which led the late Dr. Golding Bird to include this substance under the term "purpurine." The acid must be in large, the urine in small, amount.

Owing to the great difficulty of isolation, the exact nature of uroxanthin was, until lately, not properly understood; but, about three years ago, Dr. Schunk, of Manchester,[3] being engaged on an investigation of indigo (following his investigations on madder), was requested to examine some specimens of urine, and discovered in them the presence of a substance identical with the substance also discovered by him in plants, and termed "vegetable Indican."[4] There appears to be no doubt that this substance is the same with Heller's uroxanthin.

Robin and Verdeil affirmed, some years ago,[5] that Heller's uroxanthin was a mixture of urrosacine (normal pigment) with one of the new acids discovered by Marcet. But this opinion was never much received, and is now admitted to be incorrect.

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[1] Heller's Archiv für path. Chemie, 1853, p. 121.

[2] Heller's Archiv für phys. und path. Chem., 1845, p. 161.

[3] Memoirs of the Lit. and Phil. Soc. of Manchester, vol. xiv, p. 239, and vol. xii, p. 177.

[4] Vegetable indican, which is different from white indigo, has, according to Schunk, a composition of $C_{52}H_{31}N_{34}O$. When treated with acids, &c., it yields no less than six insoluble pigments, of which indigo-blue and indigo-red are the chief, and some soluble substances, viz., sugar, leucin, and volatile substances.

[5] Chimie Anatomique, tome iii, p. 565.

The pathological importance of indican will be presently considered.

Indigo-blue — uroglaucin — chromogen. — Heller discovered that a blue colouring-matter was very easily obtained from urine containing his uroxanthin, by acids or by simple exposure to the air; and to this he gave the name of uroglaucin. His observations were very much doubted, although the occurrence of a blue pigment has been long noticed, and has been described under several names.[1]

Some years before this (before 1840), Prout had observed indigo in the urine of a patient, especially after taking seidlitz powders. The indigo was sublimed and perfectly recognised. In 1850, Debuyne noticed the urine of a dropsical patient to have a blue colour;[2] and, on examination, he discovered that the pigment was indigo. In 1853, Hassall[3] examined this subject, and may be said to have first given it its true standing. He not only proved the blue colouring-matter to be indigo,[4] but affirmed the possibility of producing it in a great number of urines by exposure to the air. He thought it was derived from white indigo. Very soon afterwards, Sicherer[5] examined the same point, and came to the same conclusion.

In succeeding years, many observations were made on the blue urinary pigment, and its identity with indigo was more or less clearly acknowledged, until the observations of Schunk defined the subject still more by his examination of indican. Schunk obtained a small quantity of indigo arising from indican, from almost every specimen of urine. It then became evident that Heller was perfectly right in his repeated assertions, that the blue pigment was derived from the substance he called uroxanthin (the indican of Schunk). Lately, if any more doubt could be said to exist on the subject, it has been set at rest by a comparative elementary analysis by Kletzinsky:[6]

	C.	H.	N.	O.
Heller's uroglaucin .	73·469	3·864	10·407	12·260
Indigo-blue	73·282	3·817	10·680	12·221

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[1] It was called cyanourine, by Braconnot; urocyanine, by Martin; these were apparently mixtures of blue and red pigments.

[2] Urine colorée en blue chez un hydropique, Journal de Chimie Méd., Sept., 1850.

[3] Transactions of the Royal Society, 1853-1854.

[4] Hassall obtained isatin and anilin.

[5] Ueber die Bildung vom Indigo in menschl. Org., Liebig's Annalen, Band xc, p. 120.

[6] Wien. Med. Wochenschrift, 1859, No. 27.

Carter[1] has also shown its identity with uroglaucin. The formula for indigo-blue is $C_{16}H_5NO_2$.

In contrast, however, to all the above statements, must be placed the assertion of a most competent observer, Schlossberger;[2] who could not recognise indigo in a blue urinary pigment; he could not reduce it to white indigo, nor obtain any bodies of the phenyl series. It was not either prussian blue nor vivianite; and Schlossberger concludes that it was a peculiar organic pigment, soluble in ether. So that while we must admit the frequent occurrence of indigo, we must also allow that another organic blue pigment, distinct from indigo, may be present in urine.

Red pigment—urrhodin—indigo red (*indirubine*).—In addition to the blue pigment, Heller procured a red substance from uroxanthin, which he termed urrhodin. He never succeeded in perfectly isolating and purifying it, nor has it, to my knowledge, been ever properly examined. It has been supposed to be identical with indigo-red, and it seems probable that this is correct. Indigo-red is isomeric in composition with indigo-blue (Schunk). The mixture of uroglaucin (indigo-blue) and urrhodin (indigo-red) produces a series of tints from blue to violet red.

As already said, it cannot be yet quite decided whether or not the uroxanthin or indican, when in small quantity, should be considered a normal constituent of urine. Schunk obtained indigo from almost every healthy urine; and Carter, from a most elaborate investigation of three hundred cases, has decided that it is normal.[3] It appears, however, certain that, when in large amount, it is pathological, just as a large amount of uric acid is considered pathological.

What is the origin of indican in the animal body? and what is its relation to normal urine pigment? Is it produced from this naturally or artificially, or is it entirely distinct? While Hassall's observations seem to me to rather tend to the belief that it may be produced from normal pigment, the very small amount of indigo which can be procured from urine is, when the large amount of normal pigment is remembered, an argument against this supposed origin. Still this may be the result merely of the process employed. At any rate, the near relation of indigo to normal urine pigment, to hæmatin, and other animal pigments, is undoubted, and affords a good instance of the very close connexion between animal and vegetable colouring-matters, which has of late years attracted so much attention.

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[1] Edin. Med. Journal, 1858, vol. iv, p. 85.

[2] Thier chemie, p. 232; and Neubauer's Anleitung, 3d edit., p. 41.

[3] Edin. Journal, August, 1858.

Hassall has clearly indicated this; and the following table, taken from his paper in the 'Philosophical Transactions,' shows the close analogy between these substances.

Table copied from Hassall.

	White indigo (Crum).	Blue indigo (Crum).	Hæmatin (Mülder).	Bile pigment (Scherer).	Urinary pigment in health (Scherer).	Urinary pigment in disease (Scherer).	Melasm of the eye. (Scherer).
Carbon	72·72	73·22	70·49	68·19	58·43	61·65	58·08
Hydrogen	4·54	2·92	5·76	7·47	5·16	5·60	5·91
Nitrogen	10·60	11·26	11·16	7·07	8·83	7·29	13·76
Oxygen	12·12	12·60	12·59	17·26	27·58	27·58	22·23

That hæmatin is almost identical with, and can be changed into, normal urinary pigment and into bile-pigment, is now generally admitted, and the close relationship of indigo to all three is just as certain. The exact steps of the conversion of hæmatin into indigo cannot yet be stated, but there are several hypotheses worthy of mention.

Thus, Hassall intimates (p. 305) that, in the urine examined by Dr. Letheby and himself, leucine was thought to be present; and he observes that, as suggested by Letheby, 1 equivalent of hæmatin, and 2 of water, will give the elements of 2 equivalents of indigo and 1 of leucine—

$$\underset{\text{Hæmatin.}}{C_{44}H_{22}N_3O_6} + 2HO = \underset{\text{Indigo.}}{2C_{16}H_6N_1O_2} + \underset{\text{Leucin.}^1}{C_{12}H_{12}N_1O_4}$$

Another formula has been given by Herring. Hæmatin with water and oxygen will give indigo, benzoic acid, and ammonia—

$$\underset{\text{Hæmatin.}}{C_{44}H_{22}N_3O_6} + HO + O_3 = \underset{\text{Indigo.}^2}{C_{16}H_5N_1O_2}\ \underset{\text{Benzoic acid.}}{C_{28}H_{12}O_8}\ \underset{\text{Ammonia.}}{H_6N_2}$$

The benzoic acid would, of course, appear in the urine as hippuric acid.

These formulæ, at present, are not very material, as it would be rash to draw any conclusions from them; but they show the direction, beyond a doubt, which future explanations will take.

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[1] Leucin, however, is usually understood to contain thirteen equivalents of hydrogen.

[2] If indigo, after Crum, be considered, as in Hassall's formula, to contain six equivalents of hydrogen (or if the formula be doubled, twelve), more water would be required for the transformation.

On the whole, it does not seem at all unlikely that indigo may be an occasional, but not an invariable, product of the metamorphose of hæmatin, and that it arises from some slight perversion of metamorphosis, the nature of which is not yet known.

Whether normal or pathological, uroxanthin or indican is present in large quantity in a number of diseases. It can either be detected by the action of acids, or by giving the blue deposit. Heller states that it is especially present in diseases of the nervous tissue. But it occurs also in numerous other cases; in phthisis (Hassall); in diabetes (Heller and Schunk); in gout sometimes (author); in dysentery (Virchow and author); in the reaction stage of cholera, in immense amount (Simon, Heller, Begbie, and author); in lead colic, and after the use of mineral acids (Virchow); in Bright's disease (Heller and several authors; amongst others, Legroux lately); in ague, and is then sometimes intermittent;[1] in scarlatina (occasionally), pleurisy, and other diseases (Carter); perforation of intestines (Carter); in a case of tumour below hepatic region (Hughes); strumous peritonitis (Wilks). In fact, it is present in a vast number of cases. On the other hand, it is less common in acute febrile diseases (Heller); and it is very noticeable, that frequently, if not always when it is present in large quantities in any disease, the normal yellow pigment is deficient.

When allowed to stand, the urine containing uroxanthin becomes very acid, and, after some days, indigo may fall. This fall can be hastened by acidulating the urine, and I have then known a copious blue powder appear in a very few hours. Herring thinks that the blue powder occurring spontaneously is different from that caused by acid, but of this there is no evidence.

Usually amorphous, the blue powder is sometimes crystalline[2] in fine needles. Sometimes these needles are present when the urine is first passed.

The red pigment (indigo red) is much less common as a spontaneous or artificial sediment. Observations are yet wanting on this point. It is sometimes crystalline.

The urine containing indican may be otherwise perfectly healthy,[1] as far as urea, uric acid, the chlorides, and phosphates are concerned (Sicherer), nor is there any trace of bile-pigment; yet it is certain that large quantities of indican and of uric acid are often found together—too often to allow it to be thought to be a mere coincidence.

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[1] Dressler, Ein Fall von intermittirender Albuminurie und Chromaturie. Virchow's Archiv, Band vi, p. 264. The precipitate in this case was dark brown, but there is no doubt it was indigo.

[2] Virchow (Archiv, 1847, p. 423) spoke of these crystals as having an "indigo-blue" colour, as long ago as 1847. The crystals are readily soluble in ether and alcohol, but are with difficulty crystallized again. Robin and Verdeil thought the crystals to be uric acid. This is certainly erroneous. Beale (Beale's Archives, vol. i, p. 311) has also described and figured these crystals.

The exact import of excess of indican and indigo in the urine is not quite clear.[2] It seems more common in cases of lessened than quickened metamorphosis; it is more common in the chronic atonic diseases than in the pyrexia. Perhaps it indicates deficient oxidation, as surmised by several writers; this seems, indeed, probable, but, as argued by Carter, there is yet no satisfactory proof of it. Virchow thinks that, when the formation of bile is hindered, the blue pigment is in large amount.[3] That it is derived from and represents one of the modes of metamorphosis of hæmatin is clear, but the exact mode of production, and its exact significance, must be left unsettled. It contains more carbon and nitrogen, and much less oxygen, than normal pigment, and may, like the dark-brown pigment (Bird, Scherer), eliminate more carbon from the system, or, as already said, its presence may simply imply the want of oxygen.

In addition to indigo, and Schlossberger's blue pigment, prussian blue has been supposed to be found in the urine, but, as this opinion was based merely upon the discovery of iron in a blue substance, and as possibly iron may be contained in urine indigo, as in urohæmatin (normal pigment), the subject is very doubtful.

Green pigment.—Occasionally, on exposure to the air, the urine becomes green; and I have once seen a case of eczema, in which the urine was slightly green when passed, and became more deeply tinted afterwards. In this instance, the fluid in eczematous vesicles on the skin, at first pale, become green on exposure; and this pigment was identical with the urinary pigment. Both were soluble in alcohol, and were bleached by excess of nitric acid. Landerer[1] records a case, in which a child, with enlarged spleen after intermittent, passed a grass-green urine; nitric acid turned it yellow. The green urine has been seen in many diseases; in morbus Brightii, peritonitis, spinal disease, and cystitis.[2]

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[1] Hassall has noticed in the indigo-yielding urine a large quantity of brown extractive, from which indigo could be extracted; it was probably one of the products of indican.

[2] Indican occurs in many other parts of the body, viz., in the blood sparingly (Sanson, Lassaigne, Lecanu, and lately Carter); very seldom in the bile (Chevreul); frequently in the skin (Billard, quoted by Rayer, Buchner, and Herring); in the scales of pityriasis and in the hair-sacs; in the skeleton of a new-born child (Herring); in the brain (Guntz); in the voluntary muscles, cornea, and excrements (Coccius); in a pleuritic fibrinous exudation (Carter); in the cerebro-spinal fluid? (Hoppe); in the stools of some cholera cases (author).

[3] It may be mentioned that Virchow (op. cit., p. 262) makes the remark that uroxanthin has an effect on the copper solution used in the determination of sugar; the solution is partially decomposed, and it might be supposed that sugar is present.

The nature of this pigment, whether derived from indican or indigo blue, or from bile-pigment, is not yet known. In my patient there was no trace of jaundice.

Euroerythrin red and pink pigments.—Febrile urine often contains a pigment of almost fiery red, or carmine colour, which is quite distinct from indigo-red; it is present when the urine is passed, but deepens on exposure; and if urates fall, it tints them deeply, and can be dissolved in part by alcohol, ether, and hot water. Occasionally, in organic diseases, accompanied by fever, it has a pink tint, and the urine may be pink when passed (Prout, p. 197).[3] The pink and the red pigment are very generally mixed up. The red pigment is said to occur sometimes in the perspiration.[4]

The red pigment was formerly termed rosacic acid (Prout), and subsequently purpurate of ammonia (Prout); lately, it has been called uroerythrin (Simon).[5] Golding Bird's purpurine has been generally supposed to be this pigment; but, under this name, Bird confounded two pigments, viz., the uroerythrin and indigo blue and red. Its exact nature is uncertain; Marcet thinks that it is merely the normal pigment, mixed with a large amount of one of the acids discovered by him. Verdeil holds the same opinion. It is certainly very acid, and it is probable that this opinion is correct.

The pink substance is probably the indigo red, or urrhodin of Heller, but no analysis has yet been made; and some sort of argument can be raised against the identity, on the ground that uroxanthin (indican) and uroerythrin do not generally occur together in any quantity.

While uroxanthin is in no great quantity in the urine of febrile diseases, the red pigment, without the pink, is in large amount; especially in rheumatism, febrile gout, and pneumonia (in some cases). It is less abundant in the specific fevers and in the pyrexia symptomatic of serous inflammations (pleurisy, peritonitis, and meningitis). It seems, therefore, in excess when the normal urine pigment is in excess, and herein again is in opposition to uroxanthin.

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[1] Prag Vierteljahrs., 1851, Band iii, p. 35.

[2] Heller, Archiv für path. Chem., 1853, p. 127. Heller thinks the green is produced by a mixture of blue and yellow pigment, but in my case it was certainly not so.

[3] Prout (5th edit., p. 196) says that the pink tint is not at all common. This is true as to the exquisite form, but I think most persons' experience will show that slight forms and admixtures of the pink tint with the carmine and red are very common.

[4] Landerer, quoted by Thudichum (p. 321). It is very desirable that this observation should be repeated.

[5] Thudichum (p. 320) considers uroerythrin identical with Bird's purpurine; but, as said above, as far as I can comprehend Bird's description, he must have partly referred to uroxanthin and its derivatives when he described purpurine, or must have included them, at any rate.

In organic affections of the liver, it is often in immense quantities, and the pink pigment is then often mixed with it. Golding Bird long ago proposed the presence or absence of uroerythrin as a diagnostic mark between peritoneal and hepatic ascites, and in many cases this is certainly a useful sign. Many other observers have pointed out the great excess of this substance in hepatic affections. It occurs also in splenic diseases. Its relation to bile pigment is an important subject for inquiry.

Altogether, the red pigment appears to indicate a quickened metamorphosis of hæmatin, and not as uroxanthin, a slightly perverted metamorphosis.

Brown and black pigment—melanourine (Braconnot).—Most of the dark urines are so from hæmatin; and the urine then contains albumen. Occasionally, however, a black pigment (melanin), apparently allied to and derived from hæmatin, is in the urine.[1] After some medicines the urine becomes dark coloured, particularly after tar[2] and creosote.[3] Sometimes the dark pigment is, perhaps, to be referred to some modification of indigo-blue, or some further transformation of indican.[4]

23. *Phosphorescent urine.*—Rayer[5] has collected five cases of luminous matter in the urine; sometimes the urine was luminous when it flowed from the urethra; in other cases it was so only when it fell on a hard body. In three of five cases this occurred during the winter; in one after great fatigue. All the persons were healthy. Rayer had never seen a case himself, and considers the cause to be unknown. It has been attributed to phosphoretted nitrogen gas (Guyton de Morveau), but this is uncertain. Fallot[6] describes a case that he himself witnessed; it was in a man sixty years old, of lymphatico-sanguineous temperament, whose health was good. All his life, but most in his youth, he

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[1] Marcet, Med.-Chir. Trans., vol. xii. In this case, the urine was of a deep-black colour; there was also a black or purple colouring-matter formed from the skin. The patient was an hysterical girl, who had had intermittent fever. Was this substance indigo, or it is possible that some deception was practised? Prout (Med.-Chir. Trans., vol. xxviii) noticed a dark pigment in the urine of an infant, and termed it melanic acid (hæmatin? There were no red corpuscles).

[2] Weber, in Schmidt's Jahrb., 1858, No. 1, p. 20.

[3] Pereira and Hughes, Guy's Hospital Reports, 3d series, vol. ii, p. 52.

[4] Odling, in one of Hughes's cases, found the black deposit become blue on exposure (Guy's Hospital Report, 3d series, vol. ii).

[5] Mal. des Reins, tom. i, p. 125. See also Willis.

[6] Journal des Connais. Méd., 1848; and Scherer's Report on Pathological Chemistry, in Canstatt's Jahresbericht for 1848, p. 58.

had noticed his urine to have light points in it when it passed out of the urethra; and when it fell on any hard body, it gave out bright beautiful flashes; the diet did not influence this, and the composition of the urine was normal. The phosphorescent appearance was not more marked in the winter than summer.

SECTION II.

ON URINARY SEDIMENTS.[1]

Sediments may be broadly divided into three classes, viz.:

1. Substances which have never been dissolved, but only suspended in the urine, and which commence to precipitate as soon as the urine is passed. All the most important sediments belong to this class, and consist chiefly of organic bodies derived from the structures composing the urinary organs, or of the products of diseased conditions of these organs, such as inflammation, cancer, or tubercle.

It is impossible to exaggerate the value of the evidence which is obtained from discovering any of these sediments: often they afford the only signs of kidney disease, or of implication of the kidneys in some general disease.

2. Substances which have been dissolved in the urine, but which deposit, in consequence of the change of temperature in the urine (in the renal passages, or after emission), or from the chemical changes occurring in it.

Some of these sediments are of importance; others are of very little value.

3. Substances which are altogether foreign to the urine, and are produced always after exposure to the atmosphere, such as fungi, torulæ, and vibriones.

I. *First Class of Sediments.*

1. *Mucus and epithelium from the urinary passages.*—In every specimen of tolerably concentrated urine, a light cloud of mucus forms when the urine cools. It consists chiefly of a few ill-defined granular cells, with amorphous matter; there are

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[1] For plates of the sediments, I beg to refer to Golding Bird's last edition; to Hassall's and Thudichum's works, to Beale's plates, and to the atlases of Funke and Robin and Verdeil, and to Basham's work on Bright's disease.

sometimes epithelial cells from the bladder, and occasionally, in women, epithelium from the vagina.

In many diseases the quantity of epithelium from the bladder becomes increased; this proves that there is more or less catarrhal inflammation of the mucous membrane, of which it is indeed often the only evidence. The epithelial cells are of various sizes and stages of formation, and frequently free nuclei are seen. The amorphous mucus is, under these circumstances, also increased, and sometimes forms thin transparent flakes or cylindrical bodies, which resemble somewhat the cylinders from the prostate, or even those from the kidney. They are distinguished by their less regular and string-like form, by their flatness, and by the absence of all kidney structures in them.

The epithelium from the male urethra is more flattened than that of the bladder. The epithelium from the pelvis of the kidney is of a different shape from that of the bladder; the cells are often triangular or caudate, with well-defined nuclei; they adhere together in groups of three to ten. In this last case they have an imbricated arrangement, and perhaps are more closely connected than natural by adhesive mucus. The pelvic epithelium is never found in healthy urine, but is present very commonly in catarrhal and calculous cystitis, as the ureters and pelvis are frequently implicated. Sometimes, on account of the elongated and tailed appearance, the pelvic epithelium resembles cancer-cells very closely; and this forms, in fact, the great difficulty of diagnosis, when such cells appear in the urine in suspected carcinoma of the kidney. The number of the cells, however, is often great in cancer, and is seldom so in catarrhal pyelitis. But, after death, very long caudate cells can be obtained from any part of the ureter, and often from the bladder, which really resemble almost exactly many of the caudate cells of cancer.

The renal epithelium is only found in disease; it consists of round or slightly compressed cells, or masses (if the existence of a cell-wall be denied), with well-defined nuclei, which are not cleft, like the pus nucleus, by strong acetic acid, but become smaller, at first more defined, and then gradually paler. As seen in the urine, the cells are less polygonal and rounder than they are in the renal canals.

The presence of renal epithelium proves that there is a more or less rapid desquamation from the tubes; its condition and admixture with other products may prove still greater disease. Thus, it is sometimes very fatty, the whole space between the nucleus and cell-wall being filled with round fatty globules; at other times the cells are filled with granules, and are partly disintegrated, and such granular or half-destroyed cells may adhere together, by means of a transparent substance whose chemical nature cannot be ascertained; sometimes the cells, either fatty or granular, adhere to and are mixed up with a more or less transparent or opaque exudation substance, which has been effused into and has assumed the cylindrical shape of the tubes.[1]

It is generally believed, that if a great number of the renal cells are very fatty, the rest of the renal epithelium still undetached is in the same condition; and that the kidneys are, therefore, in a state of fatty degeneration. This inference cannot be made, however, unless the great majority of the cells are found to be fatty on repeated examinations.

2. Other cell-forms, besides the epithelial, are produced by inflammatory diseases of the mucous membrane of the urinary passages. Catarrhal or specific inflammation of the urethra and bladder produces granular and pus-cells, *i. e.*, cells with a large nucleus, which becomes cleft into two, three, or more, from the action of strong acetic acid. The membrane of the ureters and of the renal tubules, when inflamed, also furnishes pus-cells, which may be passed free or mixed up with albuminous exudation.

The amount of pus is far greater in cystitis than in any form of pyelitis or nephritis.[2]

The place of origin of granular and pus-cells can only be known from a consideration of the other morphological structures, which show that the urethra, bladder, pelvis, or renal tubes are the parts affected. Whenever there is a large amount of pus, however, it is from the bladder, if there be no prostatic or other abscess communicating with the urethra.

Botryoidal bodies, composed of a cluster of dark granules, or perhaps escaped nuclei, are not unfrequently seen when many granular cells are present.

3. *Cancer-cells.*—Both in cancerous disease of the bladder and of the kidney, cells derived from the morbid growth may appear in the urine; sometimes, besides cells, there are isolated or aggregated portions of other structure, such as small blood-vessels and fibres of connective tissue, vegetations, and membranous flakes, with adherent cells and blood-corpuscles. They are frequently attended with hæmorrhage. The cells are of

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[1] A very full and excellent account of organic urinary sediments, with many good illustrations (rather too defined), is given by Dr. Basham, whose work (On Dropsy, connected with Disease of the Kidneys: London, 1858) may be referred to for fuller details.

[2] In most of the cases of cystitis the urine becomes rapidly ammoniacal, and by the action of the alkali on the pus and altered mucus, a thick, white, ropy mass is formed, which, under the microscope, shows few or only distorted pus-cells and crystals of ammoniaco-magnesian phosphate.

various kinds—round, irregular, caudate, and sometimes even like ciliated epithelium.[1]

A difficulty of diagnosis is between cancer and calculus of the kidney, producing rapid exfoliation of the pelvic epithelium (whose caudate and irregular forms are like the common cancer-cells), and some bleeding. The diagnosis must be drawn chiefly from other symptoms, especially from the pus which is usually present in calculus, from the existence of other carcinomatous tumours, from feeling the enlarged kidney, or from the existence of profound general cachexia, for which there is no other sufficient cause.

The examination of the sediment may, however, aid the diagnosis; for in calculus the cell-forms are, for the most part, by no means so perfect, large, and numerous as in cancer of the kidney.

4. *Tubercle masses.*—These are described as occurring in the urine in tubercle of the bladder, of the pelvis of the kidneys, or of the kidneys themselves; they are, however, extremely rare. Vogel[2] states that they consist of "irregular pus-cells, with an undetermined detritus, fragments of cells, unformed nuclei, and an undetermined, finely granular mass, with sometimes fragments of cholesterine crystals."

5. *Cylinders.*—Long cylindrical bodies appear in the urine, of various kinds, and of various places of origin.

In the *bladder* are probably formed the long, flat, membrane-like, twisted, or folded bodies which have been particularly described by Rayer.[3] They are perhaps altered mucus; but acetic acid acts differently on them and on mucus, as it often first renders them pale, and then dissolves them.

In the *prostate* are formed coagula[4] which are two or three times as broad as renal cylinders; they are soluble in acetic acid, and are denoted by the presence, on and in them, of yellow or yellow-green, strongly refracting bodies. They are also found in the urine[5] occasionally, though rarely.

In the *ureter* and in the *pelvis of the kidney,* coagula are sometimes formed, which are cylindrical in the former case, and pyriform or globular in the latter; their size at once denotes their origin. The only case I have seen was one of cancerous disease of the kidney, with continued hæmorrhage into the pelvis. These cylinders always contain blood-corpuscles in great numbers.

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[1] Lambl, in Virchow's Archiv, Band xv, p. 179.

[2] Op. cit., p. 214.

[3] Rayer, Mém. de la Soc. de Biologie, Paris, 1851, pl. iii, figs. 3, 4.

[4] Donné, Cours de Microscopie, Atlas, Paris, 1845, plate xiv, fig. 57, p. 260. Donne figures indistinctly what may be either bladder or prostatic cylinders. He calls them "filaments blancs," and says they are found in the first drops of normal urine at each emission (p. 28 of the explanations of the plates). They are surely very uncommon.

[5] Mayer, Ueber die Bedeutung der Gerinnsel in Harn für Nierenkrankungen, Archiv für pathol. Anat., Band v, p. 201.

In the *kidney tubes, cylinders* (*renal casts*) are found in very various diseases. They vary in breadth from $\frac{1}{500}$th to $\frac{1}{1000}$th of an inch,[1] viz. from about the breadth of the straight renal tubes to half that size. Their length is very various, from $\frac{1}{200}$th to $\frac{1}{50}$th of an inch.

All these cylinders of different origins may appear in the urine.

The distinction between the renal and much more uncommon prostate casts is easily drawn, and no one could confound the flat, thin, folded strings, rather than cylinders, which are formed (probably in the bladder), with either of these.

The renal casts differ considerably in different cases.

1. In size. It is supposed by Dr. Johnson that the large casts, which have a diameter nearly equal to that of the kidney tubes, are derived from tubes whose epithelial lining has been already detached, while the smaller casts are formed in the free channel of the tube to which the epithelium still adheres.

2. In transparency. Some are very transparent, others almost opaque. This depends on the condition of the effused material, and no constant rule can be laid down for its occurrence. Perhaps, the more acute the case, the more transparent is the cast; but in very chronic cases there may be transparent casts. In cholera, the casts always seen in the early urine of the reaction stage are often perfectly transparent. A cast with moderate opacity, a peculiar whitish appearance, and a well-defined outline, is termed by Dr. Johnson the waxy cast. According to Frerichs, the cast becomes firmer, opaque, and yellowish in colour, when it remains for a long time in the tubule.

3. In admixture with other structures. Mixed up with the material forming the cylinders are, in different cases, renal epithelium, blood-cells, granular cells, pus-cells, oily particles, uric-acid crystals, amorphous urates, oxalate-of-lime crystals, and much more rarely crystals of ammoniaco-magnesian phosphate. The epithelia adhere round the cylinder, or sometimes are diffused through its substance.

No two casts present exactly the same appearance; and in the course of the same day, under varying degrees of blood pressure, and consequently of exudation, almost all varieties of cylinder may be produced (Bence Jones and Frerichs).

Yet the amount of these varying substances in or on the cylinders is of great moment, as, if there be constantly much blood or much fat, the existence of unusual hæmorrhage or advancing fatty degeneration may be presumed. It does not appear, however, possible to diagnose the nature of the special disease of the kidney producing the cast, from the characters of the cast itself; frequently in tolerably acute croupous inflammation, and in very chronic degeneration, absolutely similar casts may be seen.[1]

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[1] Johnson on Diseases of the Kidney, 1852.

4. In the action of hydrochloric and acetic acid.—The more intense the inflammation, the more insoluble are the cylinders when acted on by hydrochloric acid.[2] The longer the cylinders remain in the kidneys, the less readily are they acted on by acetic acid.[3]

The exact chemical nature of the substance forming the renal casts is uncertain; they are, no doubt, albuminoid, and are usually called "fibrinous," but this is a pure assumption; the distinction between coagulated fibrin and coagulated albumen is not possible.

Renal cylinders are found in a great number of diseases in which there is no permanent disease of the kidneys; and, as in the case of albumen, it would be erroneous to attach too much importance to their temporary occurrence. Mayer, who has examined carefully into this point, gives the following table, in which is marked how often cylinders are found in cases in which neither the previous history nor the diagnosis as made by the attendant physician, had led to the suspicion of any kidney disease.

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[1] The following terms are used by George Johnson:

Epithelial casts.
Large waxy casts.
Small " "
Granular casts.
Oily casts.
Bloody casts.
Purulent casts.

These terms express very well the special characters of these several varieties.

Professor Vogel makes three varieties:

1. Epithelial cylinders.
2. Granular "
3. Hyaline "

The last are best made visible with iodine, and indicate, according to Vogel, a rapid and intense inflammation. On this point, however, I think reserve is necessary. See Neubauer's Anleitung, 3d edit., p. 285.

[2] Mayer, op. cit., p. 212.

[3] Frerichs, Die Bright. Nieren Krankh., 1851, p. 57.

Among 44 cases, taken indiscriminately in an hospital, there were—	Cylinders and albumen.	Cylinders without albumen.	Albumen without cylinders.	Neither albumen nor cylinders.
14 Pneumonia	10	1	2	1
2 Bronchiectasis	2	...	...	...
4 Tuberculosis	2	1	...	1
3 Pleuritic effusion ...	2	...	...	1
1 Empyema	...	...	...	1
2 Emphysema	...	...	...	2
6 Heart disease	2	...	...	4
1 Typhus abdominalis ...	1	...	...	...
4 Intermittent	1	...	...	3
1 Morbus maculosus ...	...	...	...	1
1 Trismus and tetanus ...	...	...	...	1
1 Spinal paraplegia ...	...	...	...	1
1 Typhlitis stercoralis ...	...	...	...	1
3 Varioloid	...	...	...	3
44	20	2	2	20

I have not found cylinders nearly so common as Mayer states; but it is clear that, in many acute diseases, the kidneys are more or less congested, and there is a temporary catarrhal or croupous condition of the lining membrane of the tubules, which may produce desquamation of the epithelium and cylinders, with dissolved albumen in the urine, or, even in some rare cases, without albumen.

6. *Kidney structures.*—In a case of sub-acute Bright's disease, Dinstl[1] described a sediment in the urine, containing, among other things, actual renal tubes and Malpighian bodies to which the epithelium was still adherent. After death, cystic-like cavities were found in the cortical substance near the surface, as large as a hazel-nut, or even walnut, and it is presumed that it was from these parts the detached kidney structures had proceeded.

7. *Blood.*—Blood-corpuscles in the urine always indicate rupture of vessels somewhere in the urinary passages. The site of this rupture may be known in some cases by the cells being intermingled with renal epithelium, or being entangled in renal cylinders. In other cases, if the blood-cells be quite free, their origin can be known only from other symptoms. Usually, if hæmorrhage be copious, it is from the bladder; carcinoma of the kidney, and more rarely calculus in the pelvis of the kidney, will, however, give rise to as great hæmorrhage.

The blood-corpuscles are sometimes almost perfect in form in the urine; at other times they are acted on by the saline urine, and have lost their contents and are collapsed, or are distended. They sometimes lessen in size considerably; and I have no doubt that C. W. Balfour[1] is right in stating, that the "small organic globules" of Bird are modified blood-corpuscles.

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[1] Schmidt's Jahrb., 1858, No. 12, p. 288.

The chief causes of hæmorrhage are—

1. Intense inflammation (gonorrheal and non-gonorrheal) of the urethra and prostate.
2. Congestion of the bladder in adynamic fevers.
3. Acute cystitis (traumatic or otherwise).
4. Stone in the bladder.
5. Carcinomatous and villoid disease of the bladder.
6. Stone in the pelvis of the kidney.
7. Non-calculous pyelitis (rare).
8. Carcinomatous disease of the kidney.
9. Tuberculous disease of the kidney (very rare).
10. Congestion and inflammation of the kidneys in various acute disorders, as acute Bright's disease, variola, typhus, malignant measles, &c.
11. Congestion of the kidneys produced by medicine, as cantharides, turpentine, &c.
12. Purpura and scorbutus.
13. Unknown conditions of the kidney or of the blood, as in the hæmaturia of the Mauritius.[2]

When blood-corpuscles are in the urine, albumen is of course also present. With a little practice, it is not difficult to decide whether or not the amount of albumen can or cannot be accounted for by the amount of blood. If it cannot, *i. e.*, if the albumen be in great excess as compared to the blood-corpuscles, there is great probability of kidney disease being present.

8. *Fibrine.*—Fibrine (*i. e.*, an albuminoid substance which spontaneously coagulates) is present in many cases in bloody urine. It is sometimes present, however, when there are few or no corpuscles. The coagulation occurs immediately the urine is passed, or not for several hours afterwards.

Most commonly the urine contains also fat and albumen (chylo-serous urine); the occurrence of fibrine *per se* is extremely rare.

9. *Corpora amylacea.*—Roundish bodies with concentric layers, which give the peculiar violet colour with iodine and sulphuric acid, have been noticed by two or three observers. Whether they indicate the lardaceous or so-called "amyloid"

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[1] Lancet, Dec., 1855.

[2] Rayer, iii, pp. 373—428. Willis on Urinary Diseases, 1838, p. 168, et seq. Willis records a remarkable case of idiopathic hæmaturia, which was recurrent for many years, and was probably attributable to dietetic irregularities.

degeneration of the kidneys is not yet certain, but it is probable.

10. *Fat.*—Most commonly when fat is present, it is free and suspended in the urine. Much more rarely, as mentioned in the previous section, the fat is in combination, and is indetectible except on chemical analysis.

When passed in large quantities, the fat is evident to the unaided eye, and gives the urine a turbid emulsion-like appearance. In small quantities, it forms part of a sediment, and is detected only by the microscope.

When the fat is in large quantities, it may be derived from fatty food. (Rayer[1] and Bernard[2] in dogs).

Mettenheimer[3] has seen it after the use of cod-liver oil in one case, and of emulsio cannabina in another; the cause of the passage of the fat in such cases is quite unknown. It may be inferred, however, from the observations of Lanz, that the occurrence is more common than is usually supposed.

In other cases, however, the passage of the fat is not so obviously connected with food, and in addition to fat there is albumen, and in some cases fibrine also, in the urine. From the very fine division of the fatty particles, and probably from the presence of molecular coagulated albumen, the urine has a milky appearance, and has received the names of the chylo-serous, chylous, or milky urine. When there is fibrine, a white coagulum of varying size forms, and is sometimes extremely firm. Occasionally a few blood particles are present, and give a red tinge to the coagulum.

The causes of the milky or so-called chylous urine are at present unknown; it is not necessarily connected with food; it is sometimes evidently augmented by exercise.[4] Gallic acid may check it temporarily, as if the vessels of the kidney were relaxed; it may continue for many years without much, if any, detriment to the health.

In a third class of cases the fat is in small quantity, and only detectible microscopically; it may then be derived from the food, or be an evidence of fatty degeneration of the kidney. In this last case, it is both free and in the interior of renal epithelium.

Gmelin noted the occurrence of cholesterin in the urine; and lately Beale[5] has extracted cholesterin in some amount from the sediments forming in the urine passed by persons with fatty degeneration of the kidneys.

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[1] Op. cit., p. 171.

[2] Leçons, tome ii, p. 86.

[3] Ausscheidung von Fett durch den Urin von Dr. C. Mettenheimer (Archiv des Vereins für wissen. Heilkunde, Band i, p. 374).

[4] Bence Jones, Medico-Chirurg. Transact., 1850—1853.

[5] Archives of Medicine, 1851, vol. i, p. 8.

11. *Uro-stealith.*—Some calculi, composed of a peculiar fatty substance, were examined some years ago by Heller;[1] and lately Dr. William Moore, of Dublin, has met with another case of this curious affection.[2] To Moore's paper in the 'Dublin Journal' I beg to refer for full details.

12. *Spermatozoa* occur in variable numbers, according to circumstances. They are at once recognised by their form.

13. *Sarcinæ* have been found by Mackay, so long ago as 1848 (quoted by Begbie), by Heller,[3] Welcker, Beale, Begbie,[4] Johnson, and others. Hepwood ('Microscopical Journal,' No. 16) found sarcina in the pelvis of the kidney. Rossmann[5] thinks that the sarcina of the urine is a different variety from the sarcina of the stomach, and names it *S. Welckeri.* Welcker,[6] in his last paper, describes the sarcina minutely, and it would appear that the cells of the urinary sarcina are decidedly very much smaller than in the case of the stomach or lung sarcina; the largest masses are not composed of more than sixty-four cells. In Begbie's case, the sarcinæ were present for two months.

14. *Hydatids* (Echinococci) forming in the kidney, or in surrounding parts and opening into the kidney, are described by several authors. Generally some hooklets of the Echinococcus may be seen, but occasionally only portions of the cyst are noted.[7]

15. *Hair* is sometimes found in the urine or in calculi. It has three origins:[8]

1st. It is formed in the urinary passages. This is rare; is seen in both sexes; its causes are unknown.

2d. It is formed in cysts which have opened into the bladder. These cases occur only in women.

3d. It has entered from without, being either introduced intentionally or through vagino-vesical fistulæ. The intentional introduction is the most common cause.

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[1] Heller's Archiv für path. Chem., 1844 and 1845.

[2] Dublin Med. Journal, 1854, vol. xvii, p. 474.

[3] Archiv für path. Chem., 1852-4.

[4] Edin. Med. Journ., April, 1857.

[5] Virchow's Archiv, Band xiv, p. 393.

[6] Henle's Zeitsch., 1859, Band v, p. 199.

[7] Guitrac, Observ. d'hydatids rendus par les voies urinaires. Journal de Méd. de Bordeaux, 1852, Oct.
Simon, Lancet, 1853, vol. ii, No. 13.
Sieveking, „ „ „ No. 11.
Kuchenmeister, Deutsche Klinik, 1852, No. 25.
See Med. Times and Gazette, February, 1855.

[8] Rayer, Recherches sur la Trichiasis des voies urinaires, Gazette Méd., 1851, No. 31, p. 484.

16. *Entozoa.*—Lawrence and Farre[1] have described two kinds of worms passed from the bladder, and Farre has termed one *Diplosoma crenata;* the other is unnamed. For a full description, I beg to refer to Dr. Farre's paper.

II. *Second class of Sediments, forming in the Urine after secretion.*

1. *Sediments containing uric acid and bases.*—The most common sediments in the urine are those which are known as the "yellow, lateritious, brickdust, fever" sediments, and which are composed of uric acid in various combinations with soda, potash, lime, and, rather less commonly, ammonia; they are usually coloured with normal or abnormal urine-pigment. Phosphate and oxalate of lime are also often present.

The exact composition of the sediments of uric acid and bases has been a subject of much dispute. It was at one time thought that ammonia was the only base—an opinion which was probably founded, not on direct analysis, but on the fact of urate of ammonia existing in large amount in calculi. The presence, or not, of free uric acid has been also a subject of much controversy.[2]

The analyses of Heintz[3] implied that soda, and not ammonia, is a usual base. In four analyses the per-centage proportions were—

	No. 1.	No. 2.	No. 3.	No. 4.
Uric acid	81·20	81·82	81·75	80·80
Ammonia	0·09	0·95	0·60	0·40
Soda	14·92	14·27	14·41	14·76
Water and loss	3·79	2·96	3·24	4·14

The following analyses were published by Scherer in 1849,[4] and show that the composition varies more than would be inferred from Heintz's table.

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[1] Beale's Archiv of Med., vol. i, p. 290.

[2] Heintz has strongly denied the occurrence of free uric acid in the lateritious sediment, and asserts that it is simply acid urate of certain bases.

[3] Heller's Archiv, 1845, p. 246.

[4] Canstatt's Jahresberichte for 1848. Scherer's Report on Pathological Chemistry, p. 57.

In four cases of lateritious sediment, the per-centage composition was as follows:

	No. 1.	No. 2.	No. 3.	No. 4.
Uric acid	82·89	80·02	81·31	82·89
Ammonia	2·30	8·29	7·09	2·23
Potash	2·04	1·38	2·80	2·04
Soda	0·55	2·05	0·17	0·55
Lime	0 56	0·34	0 26	0·55
Phosphate of lime...	0·37	2·72	...	...
Oxalate of lime	0·33			
Colouring-matter and loss ...	11·03	5·20	7·66	11·74
	100·00	100·00	100·00	100·00

A glance at this table will show that the uric acid is in great excess of the bases. Thus, to take the analysis of No. 3 in Scherer's table—

Ammonia	7·09	would take of uric acid	43·28
Soda	0·17	„	0·91
Potash	2·80	„	9·48
Lime	0·26	„	1·65
		Total	55·32

Uric acid to the amount of 25·99 grains in every 100 of the sediment must have been therefore uncombined. A still greater quantity would be uncombined in analyses 1 and 4.

Another fact evident from the tables is the constancy of the per-centage amount of uric acid; and in spite of the great variation of the bases, this would lead us to believe that the uric acid is in some constant form of combination.

The following analyses of four specimens were made by Hassall:[1]

	No. 1.	No. 2.	No. 3.	No. 4.
Biurate of lime	61	70	48·37	20·00
„ ammonia	13	9	10·06	19·50
„ potash	traces	...	57·12	42 00
Moisture	19	16	11·74	10·00
Pink colouring-matter	7	5	2·71	8·5
	100	100	100·00	100·00

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[1] British and Foreign Medico-Chir. Review, 1853, July, p. 132.

Whatever be the composition of the deposit, it dissolves with great readiness when the urine is heated to 130°; nor has any instance ever been known when this did not occur, except in the case of the dense globular urate of ammonia, which requires more water and longer boiling. Acids decompose it, and liberate uric acid.

Under the microscope three forms are seen, viz., irregularly formed or amorphous particles, round globules,[1] of various size, and fine acicular and prismatic crystals.[2] The crystals are sometimes single or grouped; occasionally the acicular crystals project from the surface of a dark globule of urate of soda, or ammonia, or an accidental impurity. The round globules have sometimes hooked or curved projections, which may themselves be studded with minute crystals. Sometimes two globules adhere together, or fuse into each other so as to form true dumb-bells.

The special composition of these forms is not known. It is generally assumed that the amorphous powder is urate of lime, potash, or soda; that the globules and crystals are urate of ammonia and of soda; and that the globules with projections are urate of soda. No separation has yet been made of these several forms of deposit; but this opinion is founded on the fact that these several compounds, when pure, crystallize out of their solutions in these forms. According to Heintz, when the urate of lime exists alone, it forms globules; and so do the urates of ammonia and soda, when they precipitate out of a solution of chloride of sodium. When the three urates are together, however, the precipitate is amorphous. The extractive matters of the urine also have an influence on the form, and prevent the formation of crystals.

Sometimes the round globular form is given by the deposit of the urate upon some foreign substance;[3] even, according to Inman, on the spores of fungi.[4] An acid added to the deposit decomposes it, and uric acid crystallizes out.

The causes of the deposit of urates are very various, and in many cases two or more are acting simultaneously.

It is quite certain that the deposit of urates is not necessarily connected with any absolute excess of uric acid, and to speak therefore of an "uric acid diathesis" simply because there is a tendency to the deposit of urates is a great error. Yet there is no doubt, that sometimes the deposit is owing to an absolute or relative excess of uric acid.

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[1] Boedeker has procured artificial sediments of urate of soda, which exactly resemble in optical characters oil-globules. Henle's Zeitsch., 1859, Band vii, p. 127.

[2] For drawings of the prismatic crystals of urate of soda, see Lehmann's Handbuch der Phys. Chem., 2d edit., 1859, p. 80. Lehmann states that they appear in the urine passing from the acid to the alkaline fermentation. During the fermentation, some of the "extractive-like" matters which hinder the crystallization of the urate are destroyed.

[3] Quevenne, in Henle's Handb. der rat. pathol., Band ii, p. 313.

[4] Med. Times and Gazette, Dec., 1851.

The urates will be found to deposit at two different periods after emission.

1. Almost immediately, *i. e.*, as soon as the temperature of the urine has fallen to the temperature of the atmosphere. In this case the deposit is owing to a diminution in the quantity of water from any cause, usually from a febrile condition, and to the fall of temperature. Very frequently, but not necessarily, the uric acid is in excess also; and the urine contains much pigment, and is highly acid, or very rapidly becomes so.

2. In other cases, the urates deposit after some hours; long after the temperatures of the urine and air have been equalized. In this case the cause is not simple cooling and deficiency of water, but increase of acidity from changes in the normal pigment and extractives (Scherer), or in uroxanthin. It has not been determined what acid is formed, but it is probably the lactic, and sometimes the acetic or butyric. The deposit may sometimes be, as it were, anticipated in urine of this kind, by adding a drop of acid, when an immediate precipitate is formed of amorphous uric acid and urates of lime and soda. (This is the "urine critique" of Martin Solon.)

In addition to the increased acidity, it is extremely probable that the change in the pigment produced by oxidation has an influence in precipitating the urates. It is not impossible that uric acid and the pigment will be found to be in some kind of combination, which the alteration in the pigment breaks up.

Most deposits of urates are owing to the influence of one or more of these causes, viz.—

1. Absolute increase of the uric acid.
2. Diminution of water, with, of course, relative excess of uric acid.
3. Increase of acidity before and after emission, and altered pigment.

These causes are not sufficient, however, for all cases; deposit of urates will occur in pale urine without deficiency of water, increase of acidity, or excess of uric acid. Sometimes such urine is almost neutral; and phosphate of lime, and less commonly a small quantity of ammoniaco-magnesian phosphate, are found with the amorphous urates. Perhaps, as a cause of precipitation in such cases, there may be deficiency of the phosphate of soda, which exerts so great a solvent power on the urates, but at present I know of no analyses which prove this.

2. *Sediments composed of uric acid.*—Deposits of crystallized

uric acid may occur mixed up with the amorphous urates; sometimes, however, the crystals are present alone.

They are of various shapes, and sometimes indefinable; but the most characteristic can be referred to some variety of the rhomb—rhombic prisms or rhombic plates.[1]

A variety is formed by thin hexagonal plates, closely resembling those of cystine. Out of the body, uric acid can be made to crystallize in dumb-bells,[2] but I am not aware that this has been proved to occur in urine.

The mere occurrence of this sediment does not prove that an excess of uric acid is formed in the body, and is present in the urine; and the expression of "uric acid diathesis," if it is founded simply on the occurrence of such a sediment, is as great a mistake as in the case of the amorphous urates. The only cause of the deposit of uric acid is the presence of acid to such an extent as not only to convert all the neutral phosphate of soda into acid phosphate, but to take its base from the uric acid. The uric acid may or may not be in actual excess. It does not follow that the acidity should be owing to a single acid; it is owing either to an augmentation of all the usual acids of the urine—the sulphuric, phosphoric, and perhaps the hippuric, the lactic,[3] and the carbonic, so that the bases are insufficient to neutralize them, or to the formation of acids after emission of the urine, viz., probably, the lactic, acetic, butyric, or oxalic.

It is, of course, possible that the deposit of uric acid may be owing, not to excess of other acids, but to absolute deficiency of alkali; but no facts have yet been discovered on this point.

The two causes of increased acidity of the urine (viz., excess of normal acids, and formation of acid after emission) are sometimes in simultaneous action. The urine depositing lithic acid, without urates, is not usually the high-coloured red-pigment-loaded urine, but is yellow and transparent; the acid is deposited slowly, and without admixture with urates. As already said, uroxanthin (indican) is often in large quantity, and, as Virchow suggests, it may more rapidly form acid than common pigment.

3. *Sediments of hippuric acid.*—Owing to the much greater solubility of the salts of hippuric acid, and of the acid itself, sediments are uncommon. When hippuric acid does precipitate, it appears generally to be in a free state, and to be thrown

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[1] See Bird, Thudichum, and Lehmann (Handbuch der phys. Chem., 2d edit., 1859), for a full account of the crystallography.

[2] Frick. I have obtained the most perfect dumb-bells of uric acid, and am sure that the doubt expressed on this point by Birkett, in the last edition of Golding Bird's work on Urinary Deposits, is not correct.

[3] The lactic acid, though not a constituent of healthy urine, is apparently very common in disease.

down by a great excess of stronger acids, or on account of its own excessive quantity. But even after much benzoic acid is taken, when the amount of hippuric acid is large, it will seldom precipitate spontaneously.

When it does so, it is either in the shape of long four-sided acuminated prisms, or of acicular needles. These last often are mixed up with, and even are fixed on, uric-acid crystals.[1] They are often confounded with uric acid, and even with crystals of phosphates; from these last, however, they are at once distinguished by their insolubility in acids. From the uric acid they can be separated by boiling with strong alcohol.

4. *Sediments containing phosphoric acid.*—These sediments are formed of the ammoniaco-magnesian phosphate, the phosphate of lime, and the phosphate of magnesia.

The ammoniaco-magnesian phosphate appears in the form of beautiful transparent prisms, or of foliaceous, penniform, or stellar prisms or crystals. The latter were usually considered to be a bibasic phosphate, but an analysis of Griffith's shows that the prismatic and the feathery phosphate have the same composition,[2] and that the difference is owing to the amount of ammonia in the urine being small, and the crystallization slow, in the first case, while in the second, the amount of ammonia in the urine is great, and the crystallization is quick. The penniform and stellar prismatic crystals have been stated by Hassall to be phosphate of lime.[3]

The phosphate of lime and the phosphate of magnesia (which is more uncommon) form a white amorphous powder, or round small globules, or sometimes prismatic crystals with oblique or dihedral summits.[4]

Acids dissolve all these sediments. Heat has no effect.

Sediments of phosphates and urates may occur together under two circumstances; first, when urates having been deposited, the urea decomposes to a slight extent—enough to form the

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[1] Vogel, in Neubauer's Anleitung, 3d edit., p. 269.

[2] Griffith (Lancet, 1852) found the feathery phosphate to be composed, in 100 parts, of—

Phosphoric acid	29·09
Magnesia	16·30
Ammonia	6·93
Water	47·68
	100·00

[3] Hassall, Brit. and For. Med.-Chir. Rev., July, 1853, p. 143.

[4] Hassall, Lancet, 1853. Hassall has recently stated (Proceedings of the Royal Society, 1860) that crystallized phosphate of lime is common—much more than the amorphous phosphate, which indeed he looks upon as unusual. Figures of crystallized phosphate of lime, and of magnesia, are given by Hassall in the Lancet, Jan., 1858. I have found the amorphous phosphate very common.

ammoniaco-phosphate, and yet not to dissolve the urate; and secondly, when crystallized uric acid has formed, and been acted upon by the ammonia formed from the urea. The crystals of uric acid disappear, and are replaced by round globules of urate of ammonia, which is mixed with the phosphatic precipitation.

The cause of the precipitation of the ammoniaco-magnesian phosphate is not the excess of phosphoric acid or of the bases, but is almost always produced by the decomposition of the urea.[1] The carbonate of ammonia thus produced lessens the acidity of the urine, and the ammonia partly combines with the phosphate of magnesia. As soon as the acidity declines to a certain point, the ammoniaco-magnesian phosphate, with usually more or less of the phosphate of lime, precipitates. It is not necessary that the urine should be completely alkaline or neutral, to permit this. The deposit commences on the surface of the fluid, where the urea is most exposed to the air. In some cases, possibly, there may be an excess of muriate of ammonia in the urine, and ammoniaco-magnesian phosphate may precipitate without decomposition of the urea, but this is certainly much more uncommon.

If the urine becomes alkaline from fixed alkali, and not from ammonia, the phosphate of lime and the phosphate of magnesia are thrown down. This occurs sometimes after vegetable food, or after the carbonates of the fixed alkalies, or the salts forming them, have been taken, though usually the excess of carbonic acid keeps these salts dissolved. Usually there is also rapid decomposition of the urea in these cases, and the ammonia unites with the phosphate of magnesia. The presence of an unusual amount of mucus or of pus promotes the appearance of the ammoniaco-magnesian phosphate by aiding the decomposition of the urea. So also in urine the acidity of which is lessened, as in many chronic diseases, or after convalescence from acute diseases, the urea decomposes more rapidly than in health, and ammoniaco-magnesian and other phosphates precipitate. Or even if the urea does not decompose, amorphous phosphates will fall in urine of such feeble acidity.

In some old cases of chronic cystitis, when the urine becomes alkaline within the bladder, phosphates precipitate in considerable amount, and are often retained in the bladder for some time, and then are passed in large quantities, mixed up with tenacious pus and mucus.[2] This does not prove that there has been any excess in the formation of phosphoric acid, but merely shows there has been retarded elimination which is at last compensated for by increased discharge.

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[1] Lecanu first thoroughly understood this point; more lately, Owen Rees explicitly pointed out the very simple causes of the appearance of the phosphates; and Bence Jones has also very clearly explained this subject.

[2] It was conjectured by the elder Marcet that the mucous membrane of the bladder might furnish the large quantities of phosphates sometimes passed. This has not been proved.

To speak of a "phosphatic diathesis," simply from the occurrence of sediments of phosphates in the urine, is a great error. If there be such a disease as a phosphatic diathesis, it must be proved by chemical analysis, and not by the traces of chemical changes which occur after the urine is passed.

In certain cases, especially in feebly acid urine, the urine when boiled[1] becomes cloudy, from a precipitate of phosphate of lime or magnesia, or, according to Sommer and Scharling, a mixture of phosphate and carbonate of lime, with a protein compound. It has been supposed to depend on carbonic acid being driven off (Brett), or from decomposition of the urea, producing, by the boiling, a sudden lessening of the acidity of the urine.

But Scherer has long ago pointed out that the deposition occurs when the so-named neutral phosphates of lime and magnesia $2(2CaOHOPO_5)$ and $2(2MgOHOPO_5)$ are present; by boiling they form—

$$3CaOPO_5 \text{ and } 3MgPO_5 + CaO2HOPO_5 \text{ and } MgO2HOPO_5,$$

and the basic salts precipitate. This is, no doubt, the true explanation.

5. *Sediments composed of oxalate of lime.*—Oxalate of lime is found in the urine in a vast number of diseases. Taking the cases indifferently in an hospital, crystals will be found in nearly one case out of every three.

Oxalate of lime appears in the urine in three forms; octahedra; hour-glass or dumb-bell bodies; and small, flattened, disk-like bodies, something like small blood-globules, and which may be the earliest stage of the dumb-bells.[2]

The octahedral is the most common form;[3] the causes producing the dumb-bells are not known. Octahedra of oxalate of lime are very common even in health, and in an immense number of diseases. Walshe found them in 28·57 per cent. of all cases in men, and in 33 per cent. in women.[1] Racle discovered them in 36 per cent. of all cases. They are especially common in convalescence after severe diseases (Walshe and Beneke).

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[1] This point has been lately investigated by Krabbe, whose paper is only known to me from a reference in Virchow's Archiv, (Band xi, 1857, p. 478). It does not appear to throw any new light on this point. This observer states that magnesia may be present in the deposit, though the lime is always in larger quantity; that the deposit is not connected with any excess of phosphoric acid, nor necessarily with any augmentation of lime and magnesia; the amount of free acidity is, however, always lessened. Krabbe did not find, as has been stated, the acidity increased by boiling, but he confirms the statement that the sediment in part or wholly redissolves when the solution cools.

[2] Dr. Bence Jones has particularly pointed out this last form, Animal Chemistry, p. 67. A very full account of the crystals of oxalate of lime will be found in Thudichum on the Urine, p. 348.

[3] Dumb-bell crystals are formed of various substances, such as uric acid, carbonate of lime, urate of ammonia, but most commonly they are oxalate of lime. In the later editions of this work, Golding Bird was disposed to consider them as composed

Few subjects have excited so much interest as the causes of the appearance of these crystals in the urine.[2] While Golding Bird, and, following him, Beneke, Begbie,[3] and many others, have described a train of nervous and dyspeptic symptoms which accompany the appearance of these crystals, and which are supposed to be intimately connected with the increased production of oxalic acid in the system, or with a lessened destruction of it; other authorities of great weight, among whom may be reckoned Lehmann and Scherer, have denied that any connection whatever can be traced between the symptoms described and the appearance of oxalate of lime in the urine.

When the question was first discussed, however, it was not denied by any one that oxalate of lime appearing in the urine indicated that oxalic acid had existed in, and had been excreted from, the blood. But soon even this was called in question, and it was suggested that oxalic acid might be also a product of changes in the urine, after it had passed into the renal passages. It was supposed to be formed from uric acid or from urea (Henle,[4] Zimmermann, Beneke,[5] Rees[6]), either in the blood, or in the urine in the bladder, or even after emission. Owen Rees, indeed, has pushed this view to its extreme limit, and, if I do not misinterpret him, denies altogether that oxalic acid is ever formed in, and excreted from, the blood.

It will be seen at once what a chaos of opinions is implied in the above statement. If oxalic acid is formed after emission,

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of oxalurate of lime; but this view is, I think, upset by the observations of Griffiths (Medical Times and Gazette, 1851, p. 1087), who has produced the dumb-bells from oxalate of lime, and by the very complete chemical and microscopical examination made by Bacon (Edin. Med. and Surg. Journal, Oct., 1851; and American Journal of Med. Science, April, 1851). Bacon states that phosphate of lime, urate of magnesia, and oxalurate of ammonia (?), all form imperfect dumb-bell forms, from the aggregation of acicular crystals.

[1] Monthly Journal (Edin.), January, 1849.

[2] They will occasionally disappear in neutral or alkaline urine. I believe this fact was pointed out by Balman in 1850. It was noticed by Heller in 1851 (Scherer's Report in Canstatt for 1852). I have often observed this.

[3] Monthly Journal (Edin.), August, 1849.

[4] Handbuch der rat. Med. 1853, Band ii, p. 318.

[5] Zur phys. und path. des phosphors. und oxalsaure Kalkes, 1850; Zur Entwicklungsgeschichte der Oxalurie, 1852. The writings of Beneke contain a most elaborate discussion on this subject.

On Calculous Diseases and its Consequences (Croonian Lectures, 1856).

the appearance of oxalate-of-lime crystals is of little importance, in judging of the general condition of the system; if it comes partly from the blood, and is besides partly formed in the bladder or out of the body, how can we tell in any specimen how much is to be referred to the one or the other origin? If it has its origin solely in the blood, the case is comparatively simple, and the only point of difficulty is the estimation of the amount passed.

It is impossible for me to enter into the full argument of this most important question; I must content myself with the somewhat dogmatic assertion, that Dr. Garrod's case of oxalic acid in the blood[1] seems to me to be sufficient to show that oxalic acid does really occur in the blood. Lehmann's experiments are also quite decisive on this point. By freezing perfectly fresh urine, which had not been retained, and could not have had time to undergo changes which could produce oxalic acid, he found oxalate-of-lime crystals in the saline part left unfrozen. Strahl and Lieberkühn have also noticed oxalate of lime in perfectly fresh urine. Therefore, when it appears in the urine, it often has its origin in the system.[2]

But that it also forms after discharge is almost certain. No one can observe the enormous amount of oxalic acid in calculi, and believe that such abundance could ever come from the blood. It must surely be, then, in part, a product of chemical changes in the renal passages.

But what are these chemical changes? We know that uric acid can be made to yield oxalic acid by boiling with peroxide of lead, and, when introduced into the body, one of its products is oxalic acid. Even fermentation in the presence of an alkali will produce oxalic from uric acid.[3] Is it in some one of these ways, by the action of mucus, or some extractive acting as a ferment on uric acid, that oxalic acid is formed after emission? Scherer, however, has observed that *deoxidation* is more likely than *oxidation* in the urine; and certainly, if oxalic acid forms from uric acid, we should expect to find allantoin also. But this has not been yet discovered, perhaps because the amount is so small.

Does the oxalic acid form from the urea, or from some other body—the extractives, for example?

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[1] Med.-Chir. Trans., 1848. I may refer also to observations of my own, as adding some little evidence on this point. See the Medical Times and Gazette, 1854.

[2] Schmidt has found it in the mucus of the gall-bladder, and in the mucous membrane of the gravid uterus. He has suggested, therefore, that it might be formed from the mucous membrane of the urinary passages, and be at first in combination with mucus.

[3] Dr. Ranke informed me of this interesting fact, which I have not seen recorded anywhere.

To these questions I do not think an answer can be given; but the formation from uric acid seems the most likely mode.[1]

We seem, then, almost driven to believe that oxalic acid may form in the body, and be excreted by the urine; that it may form, also, in the urine after excretion. In the latter case we are yet ignorant of the exact method.

In the former case we are able to indicate various modes in which it might occur.

That it is a product of the metamorphosis of fat and of the hydrocarbons at a certain stage, has been long surmised; and if any cause arrests the metamorphosis at that stage, the oxalic acid, no longer transformed into carbonic acid, may emerge from the kidneys. And it is very interesting to learn from Lehmann, that when oxalic acid is in large quantity in the urine, so also is lactic acid, which is another product of the hydrocarbons. Duchek has endeavoured to show that it is derived from alcohol. But oxalic acid can also form from the protein bodies, without the intermediate stage of uric acid; and, lately, Neubauer[2] has particularly examined this point.

The different substances known to occur in the system, which can *artificially* be made to yield oxalic acid by oxidation, are uric acid, creatin, guanin, fats, starch, grape-sugar, milk-sugar, lactic acid, tartaric, malic, and citric acids, leucin, tyrosin, valerianic, succinic, butyric, and metacetonic acids. The artificial metamorphoses of all end, not in oxalic, but in carbonic acid; but, at almost every stage, oxalic acid can be formed.

The following table, from Neubauer, shows some of these changes:

URIC ACID,	LEUCIN,	GUANIN,
Partly oxidized, changes into—	*When partly oxidized, forms—*	*Partly oxidized, forms—*
Allantoin	Ammonia	Oxyguanin
Urea	Valerianic acid	Oxalic acid
Oxalic acid	Butyric acid	Urea
Carbonic acid	Carbonic acid	Carbonic acid.
	Oxalic acid	

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[1] I have not been able, however, to confirm Owen Rees' statement, that simply heating a sediment of urates will produce oxalate-of-lime crystals, and that Golding Bird's conclusions are vitiated by this fallacy. When the urates are free from urine, and are pure, I have never got oxalic acid without strong oxidizing agents. Racle makes a similar remark.

[2] Liebig's Annalen, Band cvi, p. 59; and Archiv des Vereins, Band iv, p. 1. Neubauer denies that oxalic acid will form in the urine, from the action of mucus on uric acid, or in any other way.

URIC ACID,	LEUCIN,	GUANIN,
By more perfect oxidation—	*By perfect oxidation, into—*	*By perfect oxidation—*
Urea	Ammonia	Urea
Oxalic acid	Carbonic acid	Oxalic acid
Carbonic acid	Water	Carbonic acid
By perfect oxidation, into—		
Urea		
Carbonic acid		

That metamorphoses similar, if not identical, occur in the body is very probable; and, certainly, considering the immense number of ways in which oxalic acid may be produced, it is not too much to assert that, independent of other evidence, we should expect it would be often formed in the system. The excretion of oxalic acid by the kidneys may be, in fact, as Schmidt, of Dorpat, long ago pointed out, a substitution for the excretion of carbonic acid by the lungs; what should have passed into carbonic acid stops at the lower oxidized grade of oxalic acid. Pavy,[1] in experiments on animals, has noticed large quantity of oxalate-of-lime crystals in the urine when the respiration was impeded; and, in disease, great dyspnœa has been supposed to produce the same effect, but this is not yet certain.[2]

If the above be a true statement, it is very likely, *à priori*, that this partial arrest in metamorphosis will be attended with some symptoms of depression or irritation, and that Bird and Begbie's descriptions are really correct.

But, in any given case, to what class of bodies, and to arrest of what metamorphosis, is the oxalic acid, when formed in the system, to be referred? Of this we are at present entirely ignorant; and the other excretory products must be more carefully examined, before an answer can be given.

If lactic acid be abundant in the urine, we may, perhaps, presume that the excess of oxalic acid is owing to a failure in the metamorphosis of hydrocarbons. If valerianic and butyric acids be in the urine, the oxalic acid may be derived from leucin. If much uric acid be present, it may be that an imperfect oxidation has prevented the formation of the full amount of urea. But such explanations are really, at present, speculative.

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[1] Lancet, Feb., 1855.

[2] If oxalic acid be a consequence of impeded oxidation, it is curious that it should be so common in the urine of children. Does it in them form after excretion?

Practically, how are we to judge whether oxalic acid has come from the blood, or from changes in the urine in the bladder? I believe that the distinction is easy. In order that oxalic acid shall form in the urine, there must be irritation from calculus, or some other cause, or there must be fermentative changes from mucus, &c., if there be no evidence of this, the oxalic acid of fresh urine must be presumed to come from the blood.

A more difficult point is to judge of the amount of oxalic acid; for there may be much or little still dissolved. Acid phosphate of soda, and even phosphoric acid, holds much oxalate in solution (Neubauer); and we may infer that no oxalic acid is present, simply because it has *not* precipitated, or that much is present, simply because all *has* precipitated. Perhaps lime-water would throw down all the oxalic acid; but this is still an imperfect plan, and it is much to be wished that some easy chemical mode could be devised of determining the exact amount of oxalic acid. Till that is done, we can only judge by roughly estimating the number of crystals which happen to be precipitated.

Beneke[1] has for some years forcibly insisted that the earthy phosphates are in large amount when much oxalic acid is present, and he attributes this to a dissolving effect exerted on the phosphates by the acid. But, as Scherer has pointed out, this can only hold good for the phosphate of magnesia, as the phosphate of lime is insoluble in oxalic acid.[2] This theory of Beneke's has not gained many adherents; and even the statement, that the earthy phosphates and oxalate of lime are simultaneously increased, is doubted by many, though Beneke's very numerous approximative determinations seem to me very strong evidence. It is certainly often the case, that large deposits of urates and of uric acid often occur when oxalic acid is abundant.

The simultaneous occurrence of lactic acid, and abundant oxalic and uric acids, has been already noticed.

6. Carbonate of lime. Occasionally carbonate of lime occurs with, usually, ammoniaco-magnesian phosphate. It is sometimes in the form of dumb-bells.[3]

7. *Sediments of Leucin.*—Leucin, when dissolved in urine, has been already noticed. As a sediment, it is probably not uncommon, and can sometimes be obtained by evaporation. It is then usually thrown down in round corpuscles, which have sometimes a rather concentric arrangement, and which in some measure as Neubauer remarks, look like heaps of fat-cells. Occasionally

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[1] Zur phys. und path. des phosph. und oxalsauren Kalkes, 1850, p. 50.

[2] Canstatt's Jahresb. für 1850; Report on Phys. Chem., p. 85.

[3] Plagge, in Virchow's Archiv, Band xix, p. 236.

it is in granular and partly crystallized masses. When crystallized from pure solutions, it often appears as fine, dark-coloured needle form crystals.[1]

8. *Sediments of Tyrosin.*—Tyrosin, when appearing as a sediment, forms a greenish-yellow sediment, composed of heaps of fine needles. These can be obtained also by evaporation.[2]

9. *Sediments of Cystin* ($C_8H_6NO_4S_2$).—Cystin, when present in the urine (see Chapter III), is either dissolved or in part precipitates. In the latter case it either forms a white or light fawn-coloured, amorphous, rather bulky sediment, or appears at once in six-sided plates; in both cases ammonia dissolves it, and from this solution it crystallizes on spontaneous evaporation. It is insoluble in acetic acid, and does not disappear when the urine is gently warmed. Calculi are generally white or yellowish, or sometimes green or bluish (from pigment?).

10. *Sediments of Xanthin.*—Although xanthin is found in rare calculi, it has not yet been unequivocally detected in sediments. Douglas Maclagan found a sediment in the urine of an hysteric girl, composed of earthy phosphates, and a substance considered to be xanthin,[3] but Scherer[4] doubts whether the reactions were characteristic.

III. *Third class of Sediments forming in the Urine after exposure to the Atmosphere.*

1. In acid urine, fungi occasionally soon appear; they have been noted by many observers,[5] and have received a very full examination from Hassall.[6] The fungus is the ***Penicilium glaucum***; and its spores, thallus, and fructification can all be found in different specimens of urine.

Hassall has observed that the Penicilium requires for its appearance a certain amount of animal matter, probably epithelium and mucus; it grows very slowly in filtered urine;

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[1] To recognise it fully, it must be separated, and then, perhaps, the best plan is to sublime it carefully. Scherer has given an excellent test, which may be used for the impure or the sublimed leucin. The suspected leucin is placed on platinum, carefully moistened, and then dried with nitric acid. An almost imperceptible flake is left. This is moistened with caustic soda, and then evaporated carefully over the spirit-lamp. The leucin then forms an oily-looking drop, which does not adhere to the platinum, but can be rolled about.

[2] Scherer's test for tyrosin is to treat it with nitric acid, like leucin, and then to use, as for leucin, a little liquor sodæ. The nitric acid gives a deep orange-yellow colour, which becomes deep yellow on evaporation. The soda gives the yellow flake a red tinge, and, on heat and evaporation, a black-brown residue is left. The distinction, therefore, between leucin and tyrosin is easy.

[3] Monthly Journal, 1851, August, p. 121.

[4] In his Report on Path. Chem., in Canstatt's Jahresb. for 1851, p. 49.

[5] Heller, Basham, Bennett of Edinburgh, Spencer Thomson (Med. Times, 1849), MacDougall (ibid.), and some others, directed particular attention to this fact twelve to fifteen years ago.

[6] Med.-Chir. Trans., vol. xxxvi, 1853, p. 23.

it wants but little air, and will appear in urine in a well-corked bottle. It is particularly influenced by temperature, and grows most rapidly in acid urines containing much mucus, and exposed to a temperature of 70° or 80°.

The sporules appear often in a few hours: the smallest are perfectly globular, from $\frac{1}{11222}$d to $\frac{1}{6778}$th of an inch in diameter (Hassall); the larger sporules are vesicular, and contain an eccentric nucleus. In a few hours the smaller sporules elongate and become oval. The thallus is formed in two or three days, from both larger and smaller sporules. In addition to these sporules, large globular bodies are seen, from which also the filaments of the thallus take their rise. These large globules, however, are not merged in the thallus, as the smaller sporules are, but remain as terminal or lateral bulgings on the filaments (Hassall). After several days, a mould or aërial fructification appears on the surface.

The *Penicilium glaucum* may be found in an alkaline urine, because the previously acid urine may have become alkaline; but it does not grow, or but slightly so. The different condition in which it is found in different urines, is probably owing to variations in the acidity.

Hassall thinks the development of the Penicilium may take place even in the bladder. It occurs in albuminous and non-albuminous urine. The spores sometimes are coated with lithates; less frequently with phosphates.

2. The *Torula cerevisiæ* is found in saccharine urine, and has been supposed to be the best test of a small quantity of sugar. It begins to form in two or three hours. It appears first just below the surface of the fluid, and forms delicate gelatinous-looking little masses, which under the microscope are found to be made up of round sporules, about $\frac{1}{7000}$th of an inch in diameter. In two or three days the gelatinous masses are found to be more consistent and whiter, and then, becoming heavier, sink and form a fawn-coloured stratum, which is made up of spores much larger than those first formed ($\frac{1}{1900}$th to $\frac{1}{628}$th of an inch, Hassall), and of a few beaded threads. A few days subsequently the aërial fructification appears.

Air in large quantity is necessary for the growth of the Torula; during its growth the sugar is destroyed, carbonic acid is evolved, and various acids are produced. (See "Diabetes Mellitus.")

3. *Vibriones and Monads.*—In specimens of urine containing much mucus, with or without albumen, vibriones rapidly form; they are even detected sometimes in a few minutes after the urine is passed, but usually appear in from two to twelve hours. The urine is feebly acid or alkaline.

The vibriones are linear, about $\frac{1}{3000}$th of an inch in length, and move rapidly through the urine.

CHAPTER III.

ON THE COMPOSITION OF THE URINE IN DISEASE.

THE urine is examined in diseases for two purposes; 1st, to discover the condition of the urinary organs; 2d, to determine, as far as a single excretion will permit, the course of the abnormal metamorphoses of tissues in the body, which lead to alterations in the composition of the several excreta. To determine this with complete exactness, we require to understand thoroughly the normal metamorphosis of tissue, and the changes produced in it by disease. We are still, however, almost entirely in the dark on this great topic, and the facts now known respecting the urine in disease can be regarded as merely the preliminary inquiries necessary to prepare the ground for subsequent more complete investigation. It is, of course, extremely desirable, in disease as in health, that the urine should not be alone examined, but should be regarded in connexion with the excretions of the skin, bowels, and lungs. Everything in the body takes place with the most rigorous chemical exactness, and changes in one excretion must be intimately and accurately connected with changes in the others.

I have therefore, as far as the plan of the work would permit, referred to all the excreta, reserving, however, full details of the intestinal, pulmonary, and cutaneous discharges for a subsequent work.

In disease many of the physiological conditions of age, weight, food, atmospheric conditions, &c., are as active in producing changes in the excretions as in health. In fact, all or many of the circumstances described in the first chapter of the First Book must be in action in every case of disease; and we may erroneously attribute to the disease what is actually owing to physiological conditions. And in disease we have also the additional agencies of remedies and of the pathological processes; so that the problem becomes in the highest degree complicated and obstruse.

Moreover, owing to the difficulty of weighing sick persons, especially in acute diseases, and to the impossibility of knowing in many cases what is the amount of their physiological excretion, it is extremely difficult to estimate the exact degree of variation in the excretions.

Yet with all these difficulties and imperfections, the examination of this important subject has greatly advanced, especially since the introduction of the volumetric method of determining the urinary constituents; and we have every reason to hope that future observations will yearly improve in accuracy and in extent.[1]

In examining the urine, the first object is to determine the amount of the normal constituents, and the second is to detect the presence and quantity of abnormal substances.

In determining the amount of the normal constituents in sick persons, we must remember that we scarcely ever know beforehand what is the physiological amount proper to the individual, *i. e.* the amount he excreted daily in a state of health. And yet, without such knowledge, how are we to tell whether he is passing a greater or less quantity of water, urea, uric or sulphuric acids, &c., than he did when in health. We cannot, of course, apply to the individual the average derived from the collective analyses in a number of persons, though this has been often done. For example, the mean excretion of urea in men between twenty and forty, is 33 grammes (512 grains); but we should greatly err if, in investigating the urine of a particular patient, we concluded that, in health, he would pass 33 grammes of urea daily. A glance at the table (p. 7 of Introduction) shows that he might pass either an average of 18 grammes, or of 45 grammes daily, or any amount between these two figures. How then are we to form a conception of the patient's healthy excretion?

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[1] Proper analyses of the urine in disease were, up to a recent date, almost impossible. The determination of the urea, for example, was difficult and faulty, and demanded so long a time as to render a daily analysis impossible. Unfortunately, too, the plan was adopted of determining merely the per-centage amounts of the constituents—a method which gives very little useful information. The great work of Simon, which has been so ably translated by Day, loses some of its value from this cause; and this is the case with almost every work on the subject, except the treatises of Lecanu and Becquerel, who, a quarter of a century since, maintained the necessity of determining the absolute amount excreted in a given time. In this country, I believe, Dr. Routh was really the first who clearly perceived this point, about twenty years ago, and his observations would have been most valuable had it been possible at that time to make more frequent and continued analyses. But even after this improved method was used, the great variations occurring from day to day were not sufficiently considered, and conclusions were often attempted to be drawn from the analysis of the urine of perhaps only a single day. Moreover, and even up to the present time, the desirability of referring the amount of excretion to a definite amount of body-weight has not been always seen, and hence many observations are even now wanting in true scientific accuracy. Finally, the proper methods of calculating the results, and of fixing the true mean, were not sufficiently understood. So that good analytic processes, methodical application of these processes, and proper estimation of the numerical results given by them, were till lately all wanting. I have less hesitation in saying this, as I have myself passed through the whole series of errors here referred to.

We must either continue our observations beyond the period of illness into that of complete convalescence and health (a plan always to be adopted, if possible), or we must form a provisional estimate of what amount the patient would pass in health.

The formula for this estimate I offer merely as an attempt at a solution, and can only hope that some more satisfactory plan will soon be made out.

The ratio of excretion to body-weight is, on the whole, the most constant fact at present known, and must form the basis of our calculation. The ratio is not, however, uniform. Thus, in the case of the urea, it has been shown that, in different persons, 1 kilogramme of weight may excrete either 0·420 or 0·529 grammes of urea, or any number between the two, the difference between these two persons being thus 0·109 grammes. Therefore, if each person weighed the same, let us say 65 kilogrammes, one would excrete 27·3 and the other 34·385 grammes of urea in twenty-four hours—a difference of more than 20 per cent. These numbers refer only to mean amounts drawn from several days, but on any one day the range may be from 0·25 to 0·66, or even more. The variations are probably not less with the other ingredients.

Yet, as already said, this method offers the greatest certainty of any. I would propose to use it as follows:—As weights in this country are usually taken in pounds avoirdupois and grains, I give them only here; but a simple calculation would bring out the results in kilogrammes and grammes, if necessary.

Empirical formula for calculating the urinary excretion in a sick person whose normal excretion is unknown.

1. Ascertain the weight of the person in pounds avoirdupois.
2. Multiply the following figures[1] by the weight; the result is the excretion in grains in *twenty-four* hours:

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[1] These figures are obtained in the following way:

Column 1, from the figures in the Introduction, page 24.

Column 2, from the table in p. 41, except in the case of the PO_5 of women, which is taken at the same amount as in men.

Column 3, from the calculated amount of urea for children (p. 44), and by assuming that the other ingredients are excreted in the same ratio as the urea.

Column 4, by assuming that the excretion is midway between columns 1 and 3.

	In men between 20 and 40.	In women between 20 and 40.	In children from 3 to 8.	In children from 8 to 16.	In young men and women from 16 to 20.
Urea	3·53	2·96	6·83	5·20	4·39
Chlorine	0·875	0·817	1·44	1·097	0·926
Sulphuric acid	0·214	0·25	0·414	0·315	0·266
Phosphoric acid ...	0·336	0·336	0·65	0·495	0·418

3. Make a further correction for middle and old age, by calculating according to columns 1 or 2, and then deducting 10 per cent., if the person be between forty and fifty; 20 per cent., if between fifty and sixty; 30 per cent., if between sixty and seventy; and 50 per cent., above seventy.

These numbers are quite provisional, as the analyses are so few. Future observations will confirm or correct them.

4. Correct for diet.—If the persons have been starving for two or more days (as in some fevers), deduct one third from the calculation when made according to the table. If the diet be meagre, deduct one eighth or one sixth; if pretty plentiful, yet still below that of health, deduct one tenth.

5. Correct for movement.—If there be total inactivity, deduct one tenth; if merely quietude, deduct one twentieth.

No one can be more aware than I am of the imperfections of the above plan. I merely offer it as provisional, and as affording us, as far as I can see, the only means of forming an approximative notion of the healthy excretion of a sick person.

Corrections ought also to be made for the amount of fluid drunk, the action of the external temperature, and the condition of the other eliminating organs, &c., but I am at a loss how to determine the proper figures for these agencies. Their amount, however, should never be disregarded.

I have only given the chief urinary ingredients, as the amounts of the rest are so uncertain. The uric acid, being so little influenced by weight, cannot be calculated.

I subjoin a case of mine, to show the working of the plan. A healthy man, aged thirty, on moderate hospital diet, weighed 114 lbs. Required the physiological amount of urea in twenty-four hours.

$$3{\cdot}53 \times 114 = 402{\cdot}42 \text{ grains.}$$

Correct for moderate diet; deduct one eighth:

$$405{\cdot}42 - 50{\cdot}3 = 352{\cdot}1 \text{ grains.}$$

Column 5, by assuming that the excretion is more than that of column 1, by one quarter of the difference between column 1 (excretion in men) and column 3 (excretion in children from three to eight).

Columns 4 and 5 are merely provisional statements.

Correct for bodily inactivity; deduct one twentieth:

$$352{\cdot}1 - 17{\cdot}65 = 334{\cdot}45 \text{ grains.}$$

The physiological amount determined by actual experiment (mean of six days) in this man was 346·7 grains, being only 12 grains above the calculated amount.

If a patient's weight cannot be determined, then no correct calculation can be made; but even here it will be found useful to learn what is supposed to be the weight, and to form a rough estimate of the physiological excretion.

In some cases of disease, the urinary excretion can at once be told to be abnormal—to be either too great or too small, when, on a mean of several days, we find it much below or above any of the physiological means. Thus if we find a man aged twenty passing, on an average of six days, 850 grains of urea daily, we are quite sure this is abnormal, for the highest normal mean amount is 688 grains.[1] But we could not tell how much this exceeded the man's natural amount, without reference to his weight. Supposing his weight was 120 pounds, each pound weight would excrete 7·08 grains, which would represent an increase of 3½ grains to each pound, or nearly double the healthy amount; if he weighed 180 pounds, instead of 120, the extra amount would be only a little more than one grain to each pound, or about one fourth more than normal.

Before commencing the subject of this chapter, a preliminary objection must be examined.

Considering the occasional difficulty of diagnosis, the frequent complications of diseases, the variations in the symptoms produced by individual peculiarity, or by alterations in the force of a morbific cause, it may be argued that, instead of describing the alterations in the excretions as associated with a definite disease, it may be better to refer them to a special definite state of the system, such as heightened temperature, quickened pulse, &c.; to connect them, in fact, with a well-defined single condition, and not with a complex assemblage of symptoms.

Undoubtedly the varieties in disease are very numerous, and, in the same nosological affection, the predominance of certain symptoms may give to one case a peculiar character which may greatly influence the excretions. For example, acute rheumatism is a very definite disease; but in one person it may be attended with profuse sweating; in another, with a dry skin. Now, the urine in the two may possibly be affected by this difference in symptoms, though the disease is identical. So also in typhoid fever, in one case diarrhœa may be profuse, in another absent; the urine will be very different in the two persons.

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[1] In this application consists the great use of the tables in the Introduction; and it is hoped that tables for women and children, with the body-weight added, will soon be formed.

But, on further examination, the force of the objection disappears. The whole art of medicine is based on the postulate, that diseases can, as a rule, be diagnosed; that they form a series of natural groups; can be recognised when they again appear; and are known, from experience, to have a certain course and tendency, and to require certain treatment. If this were not possible, the art of medicine would become a mere symptomatology, without coherence, utility, or scientific character. As, therefore, we can undoubtedly distinguish different diseases, we must necessarily arrange the phenomena of the urine under the same headings; and we have simply to do for disease what we must do for health, viz., to determine, first, what is the typical constitution of the urine proper to any particular disease, and secondly, the alterations in such constitution produced by incidental circumstances, proceeding from the physiological character of the patient, or from peculiarities or variations in the course of the disease, or from treatment.

In the following pages I have not attempted to enumerate all the diseases which can be diagnosed, as the condition of the urine is not accurately known in some of them. I have selected merely well-marked types of disease, in which the analyses of the urine are sufficiently numerous and complete.

The arrangement of the different diseases is a matter of some difficulty; but the method which appears most adapted for the purpose in hand is to adopt the grand division into acute and chronic diseases, and to consider first the non-renal, and then the renal, diseases, under these headings. I have left out many analyses recorded in works, as strong medicines were given at the time, and it is impossible to know what were the effects, respectively, of the disease and the medicine.[1] I have also seldom alluded to any analysis of the urine of a single day, unless the result was manifestly beyond the range of possible error.

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[1] We have, of course, to judge of the urine in diseases uncomplicated by treatment, and then we must learn what charges in this composition are produced by remedies. It is with great reluctance that I have omitted any reference to several analyses which have given their authors no little trouble. But it seemed to me better to do this than to record observations which can only confuse the subject and increase its difficulty. I have judged myself with as much rigour as other people, and have thrown aside an immense number of analyses, as too imperfect to be used.

ACUTE DISEASES.—NON-RENAL.

Acute diseases are broadly distinguished into two classes; in one of which the disease must terminate in a certain time, and cannot become chronic; while in the other, the acute may pass into the chronic stage, and the disease may continue with migitated symptoms for some time.

Most of the diseases of the first class are specific, *i. e.*, are attributable to some special cause, or morbid entity, which is also, in many cases, capable of increase in the body on which it acts. With one exception (cholera), the specific diseases have a constant character; they are all febrile, and many of the conditions present in the urine result, not from the specific nature of the diseases, but from the febrile action which is common to so many affections.

SECTION I.

INTERMITTENT FEVER.

The observations hitherto made are divisible into two series—

1. The consideration of the urine during the fit, as compared with the urine of a non-febrile period.

2. The condition of the urine of twenty-four hours during a fever day, as compared with the twenty-four hours' urine of a non-fever day.

I. *The Urine during the fit and the apyrectic period.*

Normal Constituents.

1. The water is increased in amount (Becquerel,[1] Traube,[2] Redenbacher,[3] and Ringer[4]) during the cold and hot stages; it is most abundant at the termination of the cold, or the commencement of the hot stage; it decreases during the

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[1] Becquerel, Traité de Chimie path., Paris, 1854, p. 345; and Semiotique des Urines, Paris, 1841.

[2] Traube and Jochmann, Deutsche Klinik, No. 46, Nov., 1855.

[3] Redenbacher, Henle's Zeitschrift, (N.F.) Band ii, p. 384.

[4] Ringer, Med.-Chir. Trans., 1859. Jones, Trans. of Amer. Med. Ass., 1859.

latter part of the hot stage slowly, and rapidly during the sweating state (Ringer).

The amount of increase is various, but it is sometimes quadrupled. It is in no relation to the quantity of fluid drunk, and may be great when this is small (Ringer). The amount of water passing off by the skin and lungs in various stages of ague is unknown. The cause of this increase in the quantity of urinary water is not clear. It may be that the cutaneous excretion is lessened, and that the urinary flow is compensatory; or there may be some peculiar nervous state, which alters the pressure in the vessels of the kidney. During the intermission, it is lessened (Redenbacher).

2. The urea.—The amount of urea excreted daily by a person with ague, but who is not actually suffering from a fit, is less than in health.[1] This may be owing simply to loss of appetite, or to the imperfect nutrition or metamorphosis, or to retention. Exact experiments are yet wanting on this point.

Directly the fit commences, *i. e.*, at the very first moment of elevation of temperature, or even for some time before this, the urea, according to the latest observers, suddenly increases,[2] although every known cause of increase, as food, exercise, &c., be avoided. The increase lasts during the cold and hot stages, and then sinks, sometimes gradually, sometimes suddenly, through the sweating stage, or into the commencement of the intermittance. The amount then falls below the healthy average (Moos).

The amount of ureal increase appears to be variable. Sometimes it is very considerable; in Traube's and Redenbacher's[3] cases the amount was as much as three times the quantity that would have been excreted during an equal period of time on a fever-free day. In Mr. Ringer's case, it was even a little more than this. Moos found much less—indeed, comparatively little in neglected intermittents of old date; but, Redenbacher found the increase as great in an old neglected case as in other instances. The type of the disease (quotidian, tertian, &c.) has no influence.

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[1] Zimmermann, Hæser's Report on General Pathology, in Canstatt's Jahresb. for 1854, p. 108. Schneller, Valentin's Report on Physiology, in Canstatt for 1855, p. 108. Golding Bird, Urinary Deposits, 4th edition. Jones, Trans. of the Amer. Med. Assoc., 1859, vol. xii, p. 507 : and several later observers.

[2] Traube, op. cit. Redenbacher, op. cit. Moos, Henle's Zeitschrift, Band vii, p. 291. Ringer, Med.-Chir. Trans., 1859.

[3] The excretion per hour, in one of Redenbacher's cases, rose relatively from 1 to 3½ during the hot and cold stages, and fell to 1½ during the sweating stage. The exact amount during the cold and hot stages was no less than 4·144 grammes per hour. Had this continued for 24 hours, it would have furnished the enormous amount of 99½ grammes of urea (1536 grains).

Mr. Sidney Ringer, who has examined the changes in the water, urea, and chloride of sodium in quotidian ague, in a most elaborate paper[1] has indicated a very close connection between the temperature and the amount of urea. The increase in the urea often preceded a rise or fall in the temperature; but, with the exception of this slight difference of time, the variations of the urea and temperature observed a remarkable uniformity. The amount of urea corresponding to a degree of Fahrenheit was greater at a high than at a low temperature. The increase in the urea was definite; *i.e.*, in the fit of each day, the same amount was excreted for each degree of temperature. When the whole fit was taken, the excess of urea over the normal amount in an equal time amounted, on three days, to 0·638 grammes, 0·618 grammes, and 0·624 grammes of urea for each degree of Fahrenheit above 98°, the normal blood-heat.

The amount of rise will be best illustrated by taking the figures of a single fit, from Mr. Ringer's paper in the 'Medico-Chirurgical Transactions.'

Excretion of Urea, Chloride of Sodium, and Water, on the 7th April (Quotidian Ague, untreated).

Time.	Temperature.	Urea, in grammes, per hour.	Chloride of sodium, in grammes, per hour.	Water, in c.c., per hour.
From 3 p.m., April 6th, to 5·30 a.m., April 7th	98°	0·684	0·029	36
From 5·30 to 7 ...	97°·5	0·666	0·029	25
From 7 to 8 a.m., just before shivering ...	Rose from 98·2 to 99·8	1·361	0·384	80
From 8 to 8·30, cold stage shivering at 8 ...	Rose from 99·8 to 103·4	2·176	0·612	136
From 8·30 to 10·30, hot stage	Rose from 103·4 to 105, then fell to 102·4	1·287	0·187	62
From 11 to 5, sweating	Rose from 102·4 to 103·4, then fell to 98·6	0·935	0·064	40

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[1] Med.-Chir. Trans., 1859.

Therefore each kilogramme secreted, of urea, in grammes—

	Per hour.	Per 24 hours.
During 17 apyrectic hours ...	0·0104	0·249
During rise of temperature before shivering ...	0·0209	0·501
In cold stage	0·0330	0·792
In hot stage	0·0198	0·475
In sweating stage	0·0143	0·343

The weight of this man was 65 kilogrammes; his age was fifty-nine; the normal excretion may be calculated, according to the rules before given, as 23·16 grammes in twenty-four hours, or 0·356 to each kilogramme.

It is therefore clear, that the urea in the apyrectic hours was below the normal amount, and that it rose greatly, especially in the cold stage.

The urea has no relation to the amount of excreted water, though each falls and rises during the same period. The proportion, however, varies. The increase in the urea must be regarded, in part at least, as increased metamorphosis; and the close relation to the febrile heat certainly implies that it owns only this source, and is not caused by elimination following previous retention. What tissues are thus metamorphosed cannot be indicated. Following the increased metamorphosis, is a period in which the tissue-changes producing urea are much below the proper amount.

3. Creatine and creatinine.—Nothing is known as to these substances.

4. Pigment and extractives.—The pigment is certainly, in some cases, not increased during the fit (Zimmermann,[1] Griesinger,[2] and Jones[3]). In other cases, however, the colour is darker than usual, which, as the urine is increased in amount, would imply an augmentation of pigment. It is very desirable that this matter should be carefully investigated. In almost all febrile diseases the amount of pigment is increased, from augmented disintegration of blood-corpuscles, and it would be remarkable if ague were an exception. Jones,[3] however, in all his cases, believes that the pigment was really lessened in amount.

[1] Zimmermann, op. cit.

[2] Griesinger, Virchow's Handbuch der Path. und Ther., Band ii, p. 28 (1857).

[3] Trans. of the Amer. Med. Assoc., vol. xii, p. 507 (1859).

5. The uric acid is greatly increased during the fit, according to Zimmermann,[1] Hammond,[2] and Ranke.

Ranke[3] found no difference in the amount during the cold and the hot stage. Some hours after the paroxysm, Ranke found the urine more concentrated and rich in uric acid.

The exact amount of increase, and the relative proportion of the urea and uric acid, is not known.

After the fit there are often deposits of urates, either spontaneously or on the addition of a drop of acid, and it seems probable that the increase in the passage of uric acid continues for some time after the paroxysm.[4]

Ranke has called attention to the enlargement of the spleen in connection with the great increase of uric acid, and regards the connection between the two phenomena as not fortuitous.

6. Hippuric acid.—Nothing certain is yet known of this ingredient. Weissman[5] asserts that it is always lessened; but his method of analysis is open to objection.

7. The sulphuric acid would appear, from Hammond's case, to be little altered, but further observations are wanted.

8. Phosphoric acid is in variable amount. According to Heller, the phosphates are lessened. Hammond found the PO_5 increased in the febrile days, but the amount during the fit was not determined.

9. The chloride of sodium was found, by Traube, to be increased during the cold and hot stages to a great degree; it was more than doubled, as much as 19 grammes, or 293 grains, being excreted in six hours.

A later observation, by Howitz,[6] does not confirm this statement, and Hammond's case[7] is also negative; but Sidney Ringer's observations quite confirm Traube's statement. The chlorine was greatly increased, sometimes as much as twenty-fold (from 0·029 to 0·612 per hour, for example), and often tenfold, during the cold stage especially. The urinary water and chlorine are in close relation to each other, and the per-centage of the chlorine remains often uniform (Ringer).

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[1] Zimmermann, op. cit.

[2] Hammond, American Journal of Med. Science, April, 1858.

[3] Ranke, Ueber die Ausscheidung der Harnsaure beim Menschen, von Dr. H. Ranke. München, 1859, p. 28.

[4] Jones (Trans. of the American Med. Assoc., vol. xii, p. 581) states that the uric acid is lessened during the fit, but is in very large quantity during convalescence. Possibly, in some cases, the excretion of the excess of acid formed does not take place at once.

[5] Weissman, Henle's Zeitsch., 1858, Band ii, p. 339.

[6] Howitz, Schmidt's Jahrb., 1857, No. 9, p. 283.

[7] Hammond, Amer. Journ. Med. Sci., April, 1858.

10. The free acidity is slightly increased during the fit (Hammond), but the increase is within the limits of error.

II. When the urine of a fever day is compared with the urine of a fever-free day, the results are somewhat contradictory.

On the fever days, the amount of water is greater according to Zimmermann and Griesinger and Uhle,[1] is much less according to Hammond. No doubt, in the apyrectic period of the fever days, it falls remarkably in quantity; and perhaps this may, in some cases, be sufficient to counterbalance the increase during the fit, while in others it may not do so. Much may depend on the relative duration of the fit and of the fever-free period.

The amount of fluid also consumed on the fever and fever-free days has not yet been properly determined.

The urea has been found by several observers to be increased on the fever, as compared with the fever-free days (Traube, Zimmermann, Redenbacher, H. Ranke, Uhle[1]). On the other hand, Schneller[2] in five cases found the amount of urea to be, in three cases, less on the fever than on the fever-free days. Hammond also, when suffering himself from ague, found the urea lessened one third on a fever day, as compared with non-febrile days before and after it.

Griesinger[3] also, in a case of tertian, noticed the urea to be once increased, and once not increased, on a fever day. The chlorides were found to be lessened on the fever days, by Uhle.[1]

It is evident that here, as in the case of the water, great differences may arise from the comparative length of the apyrectic period on the fever days; from the severity, or the reverse, of the fit; from the amount of food able to be taken &c. &c.; so that a comparison of so long periods as twenty-four hours is hardly justifiable. For it may happen that all three stages of a fit may last only six or eight hours, during which time the urea is increased; and are succeeded by a period of eighteen or sixteen hours, during which the urea is very small; or, on the other hand, the fit may last eighteen or twenty hours, the fever-free hours only constituting four or six out of the whole twenty-four. It seems quite clear, in fact, that the comparison of periods of twenty-four hours is erroneous, and that the only method is to compare fever with fever-free periods. The uric acid is, as a rule, greater on the fever days; yet this rule has frequent exceptions, and the difference is often inconsiderable

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[1] In children, Schmidt's Jahresb., 1859, No. 10, p. 10. The amount of increase of urea on the fever days was from 20 to 30 per cent.

[2] Valentin's Report on Phys., in Canstatt's Jahresb. for 1855, p. 108.

[3] Virchow's Handbuch, Band ii, p. 28 (1857).

(Ranke).[1] When the attacks have altogether ceased, the uric acid on the succeeding days is found to be over the normal amount (Ranke).

Abnormal Constituents.

Albumen is found during the fit in a considerable number of cases;[2] in one tenth according to Finger, in one fourth according to Martin Solon.[3] Griesinger mentions a case in which the urine was at first albuminous during the fits; it then ceased to be so, but became albuminous in the intermission.

Blood, in some quantity, and renal cylinders are seen about as frequently as albumen, and occasionally chronic Bright's disease is a consequence of ague. Intermittent hæmaturia has been described by Elliotson and Geyères.[4]

Sugar has been said to occur, but the observations require confirmation. The extraordinary difficulty of detecting small quantities of sugar render it desirable to exercise great caution in receiving statements of the kind.

Effect of Medicines on the Urine in Ague.

When quinine is given, it does not appear so soon in the urine as in health. It has no marked effect on the water, urea, and chloride of sodium, though it may at once arrest the rise of temperature. This is a most remarkable fact; but the independent observations of Redenbacher and Ringer seem decidedly to show that, after ague has been apparently cured by quinine, there occurs in the next two or three days an increase in urea, chlorine, and water, at the hours when the fit would have occurred but for the quinine. In other words, the quinine dissociates these two symptoms, increased temperature and ureal increase; it stops the first at once, but not the second, for some days.

Of these singular facts no explanation can be given, and indeed Ringer's careful experiments, which show so close a connexion between the temperature and urea, make them the more inexplicable. It would be well to wait for more facts on this point. Whether quinine lessens uric acid as in health is not known.

The effect of other medicines has not been determined.

On the whole, the condition of the urinary excretion during the prevalence of ague appears to be one of lessened elimination, or we may perhaps say, lessened metamorphosis during the a-febrile hours, with temporary heightened metamorphosis (increase of urea and uric acid) during the fit, proportioned to the temperature. When the disease is cured, the metamorphosis and elimination are much greater than during the a-febrile, though below the amount in the febrile period.

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[1] Ranke, op. cit., p. 28.

[2] Neret. Defer, Abeille, Frerichs, Hauschka, quoted by Griesingen, op. cit., 29. On the other hand, Jones only found it once in "several hundred cases of malarial disease."

[3] Martin Solon, Gazette Médicale, 1848.

[4] Rayer, Mal. des Reins, t. iii, p. 370.

SECTION II.

YELLOW FEVER AND SEVERE REMITTENTS.

No accurate analyses of the urine in yellow fever have yet been made, but there are a great number of scattered observations. At first the urine has the usual febrile characters, is scanty, high-coloured, or very frequently, if not always, contains bile-pigment. It very soon becomes albuminous, and it is probable that it is always albuminous at some period in every case (Croker Pennel).[1] Ballot found albumen invariably in 300 cases. Certainly, in the very severe cases albumen is never absent; and very often, indeed, blood and casts of tubes are also present. It is perhaps in consequence of this profound implication of the kidney that, as pointed so ably by Dr. Blair,[2] a condition of uræmia occurs in many bad cases of yellow fever; the urea is retained, traces only appear in the urine (Blair and La Roche), and ammoniacal compounds exist in the blood, or are found in the breath, black vomit, and stools.

The urine is sometimes altogether suppressed. Porcher[3] asserts that the urea and the uric acid are absent, even when urine is passed, but his mode of examination was not very accurate.

In cases of recovery, the albumen disappears. Chronic Bright's disease is never, according to Griesinger,[4] a sequence of yellow fever (?).

In severe remittent (malarial) fever, Jones[5] found the urea increased; the uric acid lessened till convalescence, when it increased; the pigment lessened. Albumen was very rarely present. If this last fact be confirmed, it establishes another point of difference between severe remittents and true yellow fever, but Jones's observations on albuminuria in ague are not in accordance with those of other observers.

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[1] Medico-Chirurgical Trans., vol. xxxvi, p. 245. Pennell says that albumen is "always" present, and sometimes in such quantity as to make the urine quite solid with heat.

[2] British and Foreign Medico-Chirurgical Review, January, 1856, Appendix. Report on Yellow Fever, p. 45.

[3] Charleston Journal, 1858, January.

[4] Virchow's Handbuck, Band ii, p. 79.

[5] Trans. of the Amer. Med. Ass., 1859, p. 591.

SECTION III.

FEBRICULA.

In Western Europe a disease is not uncommonly seen in which there is general fever, often rather severe for the time, but running a short course of from three to fourteen days, and not necessarily presenting local complication of any kind. The only eruption ever seen consists of the spots called the "taches bleuâtres."[1]

The urine during this disease presents the very type of the so-called febrile urine; on the second or third day[2] the amount of urine is extremely small (12 to 20 ozs.), of very high specific gravity (1035—1037). A boy of fourteen years of age, with a temperature of 101° Fah., passed daily, from the fourth to the sixth day inclusive, 473 c.c., or 15 ozs., of urine, which contained 447½ grains of solids; the sulphuric acid amounted to 29½ grains. Therefore both the solids and the sulphuric acid were much over the average, considering the age of the boy and his very meagre diet. In a man aged twenty-one, at a later period, the temperature was 101·5° Fah.; the average daily amount of urine in four days was 610 c.c., or 19 ozs., of urea 370½ grains, of chloride of sodium 50½ grains, of sulphuric acid 29½ grains. The colour was very deep; there was a dense deposit of lithates. As the man was on starving diet, the amount of urea must be considered rather large.

When the temperature falls, the quantity of urine rapidly augments.

Putting aside cases of typhus and relapsing fever, the urine of which I have never examined at so early a period, none of the specific diseases have the water diminished so early in the disease. While there is thus retention of water, the amount of urea and sulphuric acid, although it may be increased (if a single case be enough for this opinion), is not nearly so much so as in the height of the more severe and prolonged fevers. The chloride of sodium, although lessened, is not so in as great a degree as in typhus and typhoid fevers, and perhaps the diminution may have been attributable entirely to the diet. In another case of febricula, with most profuse sweating, the urinary solids were not increased. Unfortunately, however, the amount of urea was not determined in this case.

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[1] Griesinger states that there may be "roseola patches," but I believe this is doubtful.

[2] These statements are taken from my own observations.

In six cases examined throughout the whole course of the disease, the urine was never albuminous.

The condition of the urine coincides with the observations on the temperature, for this seldom runs up above 102°, and in conformity with this, the ureal increase is moderate.

SECTION IV.

TYPHOID FEVER.

TYPHUS ABDOMINALIS. ILEO-TYPHUS. ENTERIC FEVER.[1]

General characters.—As cases of typhoid fever usually begin insidiously, the condition of the urine before the attack, and during the first two or three days, is uncertain. On the third or fourth days, at any rate, it assumes its special characters.

Normal Constituents.

1. The water is greatly diminished, on an average about one half; occasionally it falls even to one fourth or one sixth; thus, Professor J. Vogel mentions a case in which it fell to 350 c.c. per diem, the physiological amount of the individual being 1750 c.c. The lessening of water is most marked in the first week, according to Moos;[2] the amount rises gradually during the second and third week, and at the end of the fourth, is, except in prolonged cases, near the natural standard. There are, however, many exceptions to this rule; sometimes typhoid fever has a course only of fourteen or sixteen days; sometimes, when it is more prolonged, the symptoms become much milder about the sixteenth day, and the urine suddenly increases. Occasionally, it would seem from Alfred Vogel's,[3] and from Brattler's[4] observations, that the amount is sometimes large, even during the height of the disease.[5] Frequently the variations from day to day are considerable.

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[1] By the term "typhoid fever" is implied a continued fever diagnosed during life by its course, by the eruption of rose-coloured spots and, usually, by diarrhœa, and characterised invariably after death by disease of the Peyerian and mesenteric glands. I assume, after Jenner, that it is an entirely distinct affection from maculated typhus.

[2] Zeitschrift für rat. Med., 1855, Band vii, p. 291.

[3] Ibid.. Band iv, p. 362.

[4] Ein Beitrag zur Urologie, 1858, p. 18.

[5] It would appear, however, from Alfred Vogel's short cases, that some of the patients were nearly convalescent, and all of them drank large quantities of decoction of salep. In several of Brattler's cases, the amount of urine was small—the average for the first week was 979 c.c.

The amount of urine does not stand in any close relation to the febrile heat, *i.e.*, the thermometer may mark one day 104° Fah., and the next day 100°, and the amount of urine may be the same. I have many observations on this point. Yet there is so far a connection between the two phenomena, that when the temperature begins to fall permanently, the urine increases at once; or, according to Thierfelder,[1] two or three days after.

2. The specific gravity of the urine is high in almost all cases where the urine is scanty. The exceptional cases will be referred to hereafter. The highest I have ever noted was 1038, but the average is from 1025 to 1030 in the first two weeks. At convalescence the specific gravity diminishes, and this may occur before the amount of water increases; in other words, at convalesence the lessening of the solids of the urine is often prior to the increase in the water.

3. The urea.—Various statements have been made as to the amount of urea. Scherer, Becquerel,[2] in both his works, and Simon, state positively that the urea is diminished. The latter author even affirms that "this decided decrease of the urea below the physiological average, is a characteristic peculiarity of the urine in typhus"[3] (*i.e.*, T. abdominalis). Tomowitz also found the urea normal or lessened.[4]

There cannot be the least doubt, however, that the statements are incorrect.[5] The sources of fallacy will presently appear, but the analyses in typhoid fever are now too numerous to permit us to doubt that as a rule the urea is augmented. Professor Vogel,[6] Alfred Vogel,[7] Moos,[8] Brattler, and others, have examined many cases, and all these observations agree in showing that, certain conditions being absent, the urea is augmented during the febrile period, above the physiological standard, proper to the individual, and sinks during convalescence below this standard. I can add the evidence derived from many cases examined during their whole course to this statement.

The amount of increase varies; Alfred Vogel has noted as much as 78 grammes, or 1200 grains in twenty-four hours; the largest amount I have seen was 57 grammes, or 880 grains.

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[1] Ueber Typhus, Vierordt's Archiv, 1855, p. 212.

[2] Traité de chim. path., 1854, p. 340.

[3] Chemistry of Man, Day's translation, vol. ii, p. 244.

[4] Analecten aus dem Gebiete der pathol. Chem., von Dr. Tomowitz; Zeitschrift der Wien Aezte, 1851, Oct. and Nov., p. 844.

[5] One fallacy, which need not be again alluded to, is the fact that many of Simon's and Scherer's analyses refer only to the per-centage amount, and not to the amount excreted in twenty-four hours, or by a given weight of body.

[6] Neubauer's Anleitung, 2d edition, p. 248.

[7] Loc. cit.

[8] Loc. cit.

In most of my cases, the average increase has been about one fifth, *i.e.*, if persons ordinarily excrete 400 grains, they would during typhoid fever excrete 480. The augmentation of the urea is, according to Moos, Warnecke, and Brattler, most marked in the first week when the water and the chloride of sodium are at the lowest point. The following table, compiled from Moos' analyses (eighteen cases), shows the relative amounts of these three constituents.

Mean excretion in twenty-four hours.

	Quantity.	Specific gravity.	Urea.	ClNa.
	c.c.		Grammes	Grammes
First week	884	1024	36·9	0·9
Second „	966	1022	33·2	1·1
Third „	989	1020	25·9	3·4
Fourth „	1145	1018	22·0	10·7

Warnecke,[1] from analyses in thirty men and twenty women, has given the following mean amounts of urea in grammes in twenty-four hours :—

	Urea in Males.	Urea in Females.
	Grammes	Grammes
First week	43·2	34
Second „	39·9	30·2
Third „	30·9	24·1
Fourth „	23·2	20·5

Brattler's[2] mean results, in ten cases, are as follows :—

	Urea.	Chloride of sodium.	Phosphoric acid.
	Grammes	Grammes	Grammes
First week	39	1·8	2·6
Second „	38	2·8	2·5
Third „	27	1·7	1·5
Fourth „	21	3·7	0·9
Fifth „	16	5·2	1·6

It must be understood, however, that these tables are obtained by putting together many cases, some of them during one period, some at another. They are therefore only approximate. Still the three series are very close.

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[1] Dublin Med. Press, 1859, July and August. Translated by Moore.
[2] Ein Beitrag zur Urologie, 1858, p. 19.

In Moos' cases the urea was about one sixth above its physiological amount in the first week, while the chloride of sodium was nine tenths below it. Gradually the proportions became reversed. Brattler's cases agree very closely with those of Moos. If the fever be continued beyond the third or fourth week, the urea keeps up in amount.

The relation of the urea to the temperature is yet uncertain; my own observations are too few to enable me to speak with any confidence, and the only analyses of real (but yet subordinate) value are those of Brattler. He found a greater amount of urea the higher the temperature. But the exact amount of excretion to body weight, the precise period of the fever, the attendant symptoms, and the diet, must all be more carefully considered.

Brattler's cases gives—

Temp. Cent.		Urea in 24 hours.	
40°	(104° Fah.)	40·7 grammes	(628 grains.)
39°	(102°·5 „)	36·6 „	(565 „)
38°	(100°·5 „)	32·3 „	(498 „)
37°	(98°·6 „)	26·5 „	(409 „)
36°	(96°·8 „)	17·5 „	(270 „)

Warnecke found the urea lessened when the spleen was very large; violent hæmorrhage also lessened it.

4. The chloride of sodium, as appears from the above tables, is diminished. The amount of the diminution is very variable; in one case I noted only traces during the height of the disease, although diarrhœa and sweating were absent; while in a case, also without diarrhœa or sweating, the physiological excretion of which was 115 grains, the diminution amounted only to one half, or about 56 grains at the end of the second week, when the analyses were commenced. The numbers already quoted from Moos are probably nearly correct for most cases.

The cause of the diminution is in part found in the lessened ingress of chloride of sodium on account of the spare diet; and sometimes in the fact that large quantities pass off with the stools, or perhaps by the skin. Whether or not there is any retention in the body (as in pneumonia), is not yet determined. Alfred Vogel attributes the diminution entirely to the food, and Howitz[1] has lately advocated the same view, and has stated that if the chloride of sodium suddenly diminishes in typhoid fever, without alteration in diet, pneumonia will be generally found; and that, apart from pneumonia, febrile conditions have no influence on the chloride of sodium. In the absence of a perfect investigation, I must doubt both these statements; without change of diet or diarrhœa, and without supervening pneumonia, I have noticed remarkable variations in the chloride of sodium, and in some cases no explanation of the diminution seemed possible except that of retention in the body. Helm[1] noticed that in the Vienna epidemic, not only was the chloride lessened in all cases, but that the entire failure of it was always ominous, but I have not been able to confirm this. I have known many cases do well in which the chlorine was quite absent.

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[1] Schmidt's Jahrb., 1857, No. 9, p. 282.

5. The uric acid is uniformly increased. On this point all observations agree. The amount of increase is relatively greater than that of the urea; it is often doubled, and sometimes the increase is even more than this. According to Zimmermann[2] the increase is regular up to the fourteenth day, at which time the uric acid is double its usual amount. It then diminishes (according to this observer) to the twenty-first or twenty-eighth day, and then, during convalescence, falls below the normal amount. Spontaneous deposits of urates occur very frequently in the course of typhoid fever at all periods, but most usually perhaps in the third week. Zimmermann considers them as a sign that cure is commencing; but, from Thierfelder's accurate observations,[3] they certainly stand in no determinate relation to the fall of temperature, and Becquerel also long ago[4] showed that they appear at no determined epochs, and are not indications of cure.

When there is no spontaneous deposit, a drop of acid will often throw down a dense precipitate of urates, and of amorphous uric acid. The causes of these deposits are not different from those in other cases.

6. Hippuric acid has been stated by Lehmann to be increased at the commencement of all febrile cases. It is to be presumed that typhoid fever is not an exception to the rule, if it be correct. Weissman, however, (Henle's Zeitsch. 1858, Band ii, p. 339) has always found *less* hippuric acid than natural in "typhus" patients (abdominal typhus?)

7. The sulphuric acid varies much; if it be considered that about one third of what usually appears in healthy urine is derived at once from the sulphates or sulphur of the food, and not

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[1] Schmidt's Jahrb., 1857, No. 11, p. 256.

[2] Canstatt's Jahresberichte for 1852. Eisenmann's Report on Acute Diseases, p. 160.

[3] Vierordt's Archiv, 1855, p. 212.

[4] Semiotique des Urines, p. 248.

from tissue change, and that in typhoid fever there may be almost total abstinence, it will at once be seen that, even if the SO_3 in typhoid fever be below the healthy average, it may yet be really above the proportion which is furnished in health by the metamorphosis of tissue alone. Its amount is indeed about the healthy amount or a little above this in many cases. Thus, to refer only to my own observations, a young man passed during the height of the disease, while on very meagre diet (purging and sweating were of course absent) 26·459 grains of SO_3 daily; during health and while on good diet he passed 26·671 grains daily. Another young man passed on low diet, on the fifteenth and sixteenth days, twenty grains; during convalescence, nineteen grains; and when perfectly well, and on generous food, twenty grains. In these cases, therefore, the equal ratio of the SO_3 indicated, when the influence of food is taken into consideration, more active tissue change. In other examples, the SO_3 has been three or four grains daily above the healthy range; in many instances, it is a little below, as apparently the increased metamorphosis is not sufficient to balance the deprivation of food. Altogether, therefore, (purging and sweating being absent) the SO_3 is slightly augmented in typhoid fever as a rule.

8. The phosphoric acid follows, to a certain extent, the same rule as the SO_3, except that I have found it more generally below the healthy standard during the period of inanition.[1] According to Beneke[2] the earthy phosphates are always diminished in the early stage (from lessened food?). Whether or not the PO_5 is increased during delirium, is not positively known, as there is great difficulty in collecting the urine at that time.

9. At first the pigment is sometimes enormously increased[3] —measured in Vogel's method (by comparison with a scale of colours) it has sometimes amounted to 80 to 100 in 24 hours, the normal amount being 3—6 (Vogel). This is to be referred to increased disintegration of blood-cells. The urine is therefore much more highly coloured than the mere concentration will account for. According to Tomowitz[4] the colour is attributable only to normal pigment (urophœin) and not to any abnormal substance, such as the uroxanthin of Heller, or biliphœin.

In my analyses, which, as far as this point is concerned, are chiefly of the latter days, the amount of extractives and pigment has been decidedly below the healthy standard; but then, at this time, the destruction of blood corpuscles may have been carried far enough to produce some degree of anæmia.

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[1] Brattler's observations in ten cases at different periods of the fever (see page 246) show great variations in the PO_5, but as a rule it was lessened. The lowest amount in a man was 0·762 grains, but this was in the seventh week; the highest was 2·981, in the second week. It was evidently higher in the first and second.

[2] Zur phys. und path. des Phosph. u. oxals. Kalkes. Gott., 1850, p. 27.

[3] Professor Vogel states (Neubauer's Anleitung, 2d edition, p. 235) "that in all acute febrile diseases the quantity of pigment is greatly increased, in spite of the coincident lessening of the urine;" but, if true, in many cases there are some important exceptions. Ague appears to be one of these.

[4] Op. cit., p. 844.

Schottin has observed an increase of creatin and creatinin, doubtless from increased muscular disintegration.

10. The acidity of the urine in typhoid fever, appears always great during the early period, simply from the concentration of the urine. When the exact amount is determined by neutralizing with alkali, it is found to be below the average by one fifth or even by one fourth.[1] During the third week, when the quantity of uric, sulphuric, and probably hippuric acid is falling, the acidity lessens still more, and the urine may even become alkaline from fixed alkali. This seldom continues long, however, and probably, from the influence of increased quantities of animal food being usually given about this time, the acidity afterwards increases. The proportion of cases in which the urine becomes alkaline from fixed alkali is uncertain, as no writers have distinguished between the alkalinity of fixed alkali and ammonia.

The urine becomes alkaline from ureal decomposition, in a great number of cases, soon after being passed; there is in fact always a tendency to this when the acidity of the urine is slight; and, besides, in typhoid fever there is often partial retention in, or imperfect evacuation of, the bladder; and, in many cases, there is an increased quantity of mucus. Tomowitz noticed alkaline (ammoniacal urine, no doubt from decomposition) in no less than 90 out of 137 cases, at some period or other; but it is probable that this is much too high a proportion. In these cases, the urine is usually faintly acid or neutral when passed, and becomes alkaline in an hour or two. Deposits of phosphates of course take place. When there is great retention, the urine becomes ammoniacal in the bladder.

Whether there is an increase of ammoniacal compounds independent of ureal decomposition, is not yet known, and is evidently a point which will be decided with great difficulty. Some analyses by Scherer would seem to imply an increase.

Abnormal Constituents.

1. Albumen occurred in seven out of twenty-one of my cases, or in 33·33 per cent. In five of these cases, or in 23·8 per cent, it was temporary, and entirely disappeared before the patients left Hospital. In the other two cases it was permanent, *i.e.*, it

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[1] Professor Vogel, from numerous observations, has found "that in most diseases, acute as well as chronic, the free acidity lessens, and is almost never increased, unless large quantities of mineral acids are taken." Neubauer's Anleitung, 2d edit., p. 251.

existed when the patients left the hospital well of the fever. In one of these two, it existed when the urine was first examined; in the other, the urine, at first non-albuminous, contained afterwards blood in small quantity, casts and albumen in large quantity. Although I had no opportunity of knowing what course the kidney disease afterwards took in this case, there was evidently a very profound kidney lesion, which did not pre-exist, but was immediately excited by the fever.

Becquerel found albumen in eight out of thirty-eight cases, or in 21 per cent.; Andral noted it only in one of thirty-four cases, or 2·9 per cent.; but it may be questioned whether the urine was examined carefully every day. Griesinger found albumen commonly, though it was very temporary. In thirty-six cases he met with only four or five (!) in which it was never present.[1] Kerchensteiner[2] found albumen in a fourth part of the severe cases. Brattler noticed it nine times in twenty-three cases, or in 39 per cent.

2. Leucin and tyrosin have been found by Frerichs, but at present no observations have been made on the exact frequency or import of this occurrence. The quantity must be small. Hoppe indeed was able to find none.[3]

3. Abnormal pigment is rare; and bile pigment occurs in a very small proportion of cases.

4. Renal epithelium, casts, and blood, are sometimes seen in the cases with temporary albuminuria, but usually soon disappear. The blood in my own cases has been always in microscopic quantities; but in very bad cases, there may be a greater amount. Zimmermann states that, in all but very slight cases, *even where there is no albumen,* renal cylinders may be found;[4] on this point I cannot speak decidedly, but I doubt the accuracy of the statement.

Bladder epithelium and pus are seen in some cases in small quantities, but considerable cystitis is rare, unless there is retention from partial paralysis of the bladder.

5. Sugar has not yet been found in typhoid fever. In diabetic patients who become affected with typhoid, the sugar greatly lessens, and sometimes disappears.

Incidental circumstances affecting the Urine in Typhoid Fever.

Diarrhœa. The foregoing observations chiefly apply to cases of typhoid fever without great complication, and without any profuse amount of diarrhœa.

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[1] Virchow Handb., Band ii, p. 168.

[2] Henle's Zeitsch, 1859, Band v, p. 157.

[3] Deutsche Klinik, 1858, No. 51.

[4] Canstatt's Jahresb. for 1852. Eisenmann's Report on Acute Diseases, p. 160.

I examined the urine for four days (fifteenth to the eighteenth day inclusive) in a case without diarrhœa, and then for five days (twentieth to the twenty-fourth inclusive) during the occurrence of moderate diarrhœa (three loose stools in each twenty-four hours). At this time, according to the usual rule, the water and chloride of sodium should have been gradually augmenting. The effect of the diarrhœa was to diminish both water and solids, but in different proportions; the water was lessened by nearly one half (from 640 to 372 c.c.), the solids by one quarter (from 433 to 343 grains in each twenty-four hours). Of the several solids, the chloride of sodium was especially affected; it fell from 34 to 6½ grains in each twenty-four hours; viz., almost five sixths; the urea was lowered, but in a much less degree; the SO_3 fell from 22 to 16 grains; the phosphoric acid was unaffected. The cause of the lowering of the chloride of sodium is evident, for the typhoid stools contain a large amount,[1] and this is of course increased in diarrhœa. This and other cases prove, however, that no great amount of urea, or of compounds derived from it, pass off by the intestinal mucous membrane; and therefore this membrane is not in typhoid fever, as a rule, an eliminating channel for urea. The typhoid stools are highly ammoniacal, but this may proceed from other causes besides the decomposition of urea. All the nitrogenous extractive matters give rise to ammonia. If in diarrhœa ureal products passed off, surely the urea excreted by the kidneys would be lessened. In some cases indeed, diarrhœa does not diminish the urea at all; thus, Moos mentions a case in which, on the sixth day, without diarrhœa, the urea amounted to 36·5 grammes; and on the ninth day, with four loose stools, to 36·7 grammes.

Occasionally during diarrhœa the water remains abundant—it is even increased; but this is exceptional, and depends, perhaps, upon other obvious circumstances, such as drinking great quantities of water, or lessened action of skin.

Sweating.—The effect of great sweating, when it occurs in typhoid fever, has not yet been traced out; but it is noticeable that the amount of urine tends, as a rule, to increase after the twelfth day, when the sudamina appear.

Diet.—The effect of diet need not be discussed. It is of course unlikely that its influence will be overlooked.

Non-excretion.—Although in many cases of typhoid fever there is, throughout, an abundant excretion of urea and uric acid, this is not the case always. The urine is sometimes not only scanty, but deficient in solid matters. This state of things often coincides with what is termed the putrid, adynamic, or profound "typhoid" state. The lessening of the urea and other urinary ingredients must be ascribed, not to diminished formation, but to diminished excretion; for not only are the cases quite exceptional, but there are always coincident symptoms, which imply more or less blood-poisoning from retention. The late researches, also, of Picard,[1] have shown that in all febrile cases (even when excretion is active?) there is accumulation of urea, and doubtless of other urinary products, in the blood; and this condition, which exists in all cases, would appear to be in some carried to an extreme degree.

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[1] See Analysis of Typhoid Stools, in a clinical lecture by the Author, Medical Times, 1850, June 1. See also Zimmermann's Analyses.

I do not assert that the intense "typhoid state" is owing entirely to such retention; there are other causes, such as the profound prostration of the nervous system, the absorption of putrid matters from the intestines, the passage into the blood of the products of the splenic, hepatic, and glandular metamorphoses, or of the products of the scattered inflammations in the lungs or elsewhere, which often occur in typhoid, which are also in action. But, mixed up with these or independent of them, non-excretion of urinary products plays an important part; and some portion of the "typhoid state," which is a condition not necessary to typhoid fever, is an urinæmic condition. Such cases doubtless have misled some of those observers who have fancied that there is always diminution of the urea in typhoid fever. The diarrhœa which may attend them does not prove of benefit, probably from the fact already noted, that urea or ureal compounds do not pass off by the intestinal mucous membrane, or do so in very small amount.

The causes which thus check excretion in typhoid fever, are not well understood. Sometimes there is certainly enough kidney implication, to lead us to suppose that the transudation in the renal vessels does not occur so quickly or so perfectly as usual. But then, in other cases, there is no albumen, blood or renal cylinders in the urine; and therefore no obvious renal affection to prevent the passage of water, urea, and extractives. Yet that less water, urea, and extractives do pass, is certain; and it remains to be shown whether we are to look to the kidney-structures (as is most probable) or to lessened pressure of the blood in the renal vessels, from failing circulation; or to some special condition or combination of the urea which hinders transudation.

The non-excretion of urinary substances may occur at any period, but is perhaps most common in the third and fourth week, when the first stage of the disease is over, and when the exudation in the patches of Peyer and in the mesenteric glands is softening, when the secondary blood-poisoning occurs, and when the heart's action is most failing.

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[1] Op. cit., and in Virchow's Archiv für pathol. Anat., Band xi, p. 189. It should be said, however, that exception has been taken to Picard's analyses.

Coincident inflammations.—The usual exciting causes of inflammations, (cold, &c.), and especially the absorption into the blood of putrid substances, from the ulcerating patches of Peyer or other diseased parts, may be usually, and probably correctly, considered to be the cause of the secondary inflammations (pleurisy, lobar and lobular pneumonia, parotitis, &c.) which may occur in typhoid fever. It is probable, however, that deficient urinary excretion, may have a share in their production. I have observed the urine in one case, before and during an attack of inflammation (pleurisy) in typhoid fever. The following was the result:

	Mean of 12 days, 26th to 37th inclusive, before pleurisy.	Mean of 8 days, 38th to 45th, during acute pleurisy.
Water	584 c.c.	667 c.c.
Urea	339·4 grains	203 grains
ClNa	16·7 „	49·8 „
SO_3	20·0 „	11·3 „
PO_5	10·3 „	5·4 „

While the water was not diminished, the lessening of the urea (one-third), of the sulphuric and phosphoric acids (nearly one-half), is very remarkable; the ClNa was even increased. The effect, in fact, of the local inflammation, was precisely the reverse of that of diarrhœa, as far as the water and ClNa were concerned. I have not been able to examine any other case of typhoid fever, during the existence of a local inflammation; but as I have observed similar facts in other febrile diseases (rheumatic fever) it is extremely probable that the development of local inflammation and deficient excretion in this case, were not coincidences, but were closely allied. Of course it is most probable that the inflammation was caused by the non-secretion produced by some unrecognised condition. The condition of the urine in coincident inflammation of the lungs or brain has not yet been determined.

Inanition.—The influence of inanition is often marked at the later period of typhoid fever, in cases in which food has been too long withheld, or in which the patients were attacked with fever while debilitated from any cause, or while anæmic or convalescent from other disease.

This class of cases is not uncommon in large cities: thus, a person who has been living for some time on insufficient diet, and has been perhaps leading a very sedentary life, is attacked by typhoid fever. No doubt, before the fever, tissue metamorphosis had been inactive; and, probably, excretion had been deficient. Even the fever does not raise the excretion to the healthy standard of more robust individuals, or the previous unhealthy state still impedes excretion. It is, of course, a mere supposition, but one cannot help believing that some of the analyses which represent the urea as small in amount were in such persons. These individuals are notoriously bad subjects for fever; partly, no doubt, from the condition of their systems; partly, in all probability, because excretion is imperfect.[1]

Convalescence.—During convalescence, the excretion of urea, uric acid, pigment, extractives, and sulphuric acid, sinks for some days below the standard proper to the individual.[2] The water and the chloride of sodium are abundant. It would seem as if the intense activity of the retrogressive metamorphosis was succeeded by a state exactly the reverse. The constructive processes are active, the body gains weight, the muscles regain force, and fat is rapidly deposited. As this must be considered an healthy condition, it is to be assumed that the diminution in the urinary ingredients is not a consequence of non-excretion, but of non-formation. The length of time this state of things lasts is doubtful. Sometimes it is only for three or four days; sometimes for a week, ten days, or, perhaps, even longer.

These various circumstances — diarrhœa, medicine, diet, inanition, local inflammations and congestions, blood-poisonings from absorption of putrid matters, and deficient urinary excretion from decided kidney disease, or unknown conditions —are the chief causes which produce deviations from the usual or, if the term may be used, normal condition of the urine in typhoid fever.

Judging from the urine alone, it might be assumed that the febrile action is strongest in the first week in typhoid fever, although the temperature is highest in the second and commencement of the third week. But the diminution of the urea in the second week (if Moos' observations be correct), may be ascribed, not to decreasing fever, but to the fact that inanition and decreasing body-weight must exert a counterbalancing effect to the pyrexia.

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[1] These remarks apply more or less to all other diseases, so that I need not occupy space by referring in other cases to the effects of inanition.

[2] Brattler mentions a case in the seventh week, with great atrophy and vomiting, in which the urea was only 7 grammes in twenty-four hours.

In typhoid fever, as in so many other pyrexial conditions, we see the remarkable fact of the extraordinary increase of the uric acid. While the urea is increased by only one fifth, the uric acid is often doubled. Although their chemical composition, and the fact that uric acid introduced into the system produces urea among other products, does certainly give weight to the view that one substance is a stage of the other, their relative amounts in typhoid and other fevers, as far as these are known, do not support this hypothesis. It would seem probable, that when the urea is in large quantity, the uric acid is so also; whereas, if one is a lower grade of oxidation than the other, these amounts should be in an inverse ratio to each other. We cannot suppose that the uric acid is produced in such enormous quantities as to be incapable of conversion into urea beyond a certain point; were this the case, its amount would surely be much more variable than it is; it would not have, as it has really, a certain range in disease up to 20 to 30 grains per diem, which it never, or almost never passes. Now and then, surely we should have a much larger quantity failing to pass into urea. So also the urea may change considerably from day to day, while the uric acid may remain constant. How can this be accounted for on the hypothesis of convertibility?

Considering the apparent independence of each other of urea and uric acid, it would seem much more probable, that each is produced by the metamorphosis of a definite structure or substance; and that, under ordinary circumstances, there is no conversion of uric acid into urea. Physiology will doubtless be able to indicate whence the uric acid is derived, at present it is mere guess work to hazard an opinion; but the fact that uric acid is found in such large quantities in the spleen, the organ which is especially affected in so many pyrexial conditions, leads one to think that there may be some connection between the splenic hyperæmia and the excessive production of uric acid.

The increase in the pigment is doubtless owing to augmented blood-cell disintegration; but, whether this occurs in the vessels, or in some organ (liver or spleen?), is not known.

The excretion of SO_3 in typhoid fever indicates that there can be no unusual accumulation of sulphur-containing substances in the system, but that the SO_3 is derived merely from the slightly more rapid disintegration of the natural tissues. There is no parallelism between the SO_3 and the urea.

The effect of remedies on the urine of typhoid fever has not yet been accurately determined.

The study of the urine in typhoid fever throws at present no light on *diagnosis,* as the characters are common to so many febrile affections. It has been, indeed, considered by Moos,[1] that cases of intestinal catarrh, resembling typhoid fever, may be distinguished from it, by the fact of the urea not being increased, or the chlorides so much diminished in the former disease. The cases recorded by Moos, however, seem to me to be of uncertain diagnosis; and, in four cases, it may be questioned whether they were not really mild cases of typhoid.

The *prognosis,* in severe typhoid fever, has appeared to me to be more favorable in proportion to the free excretion of urea and uric acid. As a certain amount of urea and uric acid must be formed in every case, in proportion to the fever (the temperature?), and to the susceptibility with which the tissues of the individual undergo metamorphosis, it might be assumed that the excretion of these effete substances is a most necessary point. This is confirmed by observation; for, although a large amount of urea and uric acid indicates a high febrile state, and, therefore, so much the more danger, yet it is undoubted that there is more peril in retention than in any amount of fever and formation with elimination. The greater the excretion in typhoid fever the better; and, as long as 500 to 700 grains of urea in men, or 300 to 500 in women, are being passed in each twenty-four hours, the prognosis so far is favorable. But, whenever, while the fever continues, the urea falls much below these amounts, we may anticipate, that in consequence of it, or of the cause that produced it, a low typhoid condition may come on; or, that (probably), some local inflammation, as pleurisy, may take place, and relieve the blood for the time from some of the effete products.

The existence of slight albuminuria or hæmaturia is not of itself unfavorable, but if either be in large amount, or if there be signs of desquamative and croupous nephritis (exfoliation of epithelium, renal cylinders) some amount of retention and its consequences may be expected.

The condition of the urine influences the *treatment* of typhoid fever.

In the absence of any direct antidote, or of means of permanently decreasing the febrile heat,[2] the chief indications of treatment in typhoid fever are, I believe, to restrain the diarrhœa, to stimulate the nervous system when necessary, and to obtain a free action of the kidneys. As long as the excretion of urea and uric acid is abundant, no diuretics are necessary, but whenever the amount of the solids falls greatly, which can be known at once with sufficient accuracy, by a comparison of the quantity of urine passed in twenty-four hours, with the specific gravity, means must be taken to increase, if possible, the urinary elimination. The warm bath, with repeated small doses of the alkaline carbonates, or of the nitrate or bitartrate of potash will often effect this. I infer this simply from the increase in the water and solids, for I have not been able to make any satisfactory analyses under these circumstances.

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[1] Loc. cit.

[2] Wunderlich, however, seems to have proved the good effects of calomel when employed before the ninth day. Archiv für phys. Heilk., 1857, p. 367.

In two cases, I have tried the effects of coffee in typhoid fever. The results (see Gulstonian Lectures, 'Medical Times and Gazette,' 1855) are not very decisive, so that I shall leave them till other observations can be added to them.

SECTION V.

TYPHUS EXANTHEMATICUS.

Normal constituents.

Of the urine of typhus,[1] properly so called, we possess scarcely any knowledge. Till very lately most observers classed typhoid and typhus fevers together, and it is impossible to know to which disease their analyses referred.

The only complete analysis in undoubted typhus with which I am acquainted, was made by myself.[2] In this case the condition of the urine was that of ordinary pyrexia. The water was lessened; the urea was increased one fifth; the uric acid was in large amount, and spontaneously, or on the addition of an acid, deposited; the chlorides were entirely absent, though there was no diarrhœa or sweating; the sulphuric acid was rather high; the phosphoric acid was not determined. The free acidity was very slight, and (differing from many pyrexia) the pigment and extractive matters were throughout in small amount. In this case, the urea continued large, and the chloride of sodium small in amount, for some days after the temperature had fallen to below the normal limit. The excretion of urea was remarkably regular in amount from day to day, for during ten febrile days its range was only 15 grains (1 gramme) below the mean of the ten days, and 20 grains (1⅓ gramme) above it. And this took place with great alterations in temperature. It then, as usual, fell during convalescence, and rose again to the healthy standard in three or four days. The chloride of sodium was clearly retained in this case, for there was constipation, and the skin was dry, so that none could have passed off by the intestines or surface.[1]

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[1] A disease considered to be entirely distinct from typhoid fever. Diagnosed by the existence of a special eruption and course of symptoms. No intestinal affection, except as a complication (dysentery, intestinal catarrh).

[2] Medical Times and Gazette, March, 1857.

Edwards[2] states, that in twenty cases of typhus the urine was pale and of low specific gravity. This might have been from deficiency of $ClNa$ and pigment.

It is, however, generally stated that the urine in typhus is high

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[1] I give the table showing the urinary excretion in twenty-four hours. Weight of patient, 129 lbs. avoir. Diet low, but not starving. The effect of coffee was to relieve headache, and apparently to increase the urinary water and urea:

Day of disease.	Temp., Fah. (Mean)	Action of skin.	Action of bowels.	Amount of urine.	Urea.	$ClNa$.	SO_3.	Remarks.
				Ozs.	Grains	Grains	Grains	
8	103°	Dry	...	26	552·67	traces	38·325	No medicine
9	103°	...	...	27	542	"	39·673	"
10	102°	...	1	41	723	"	44·813	120 grains of extract of coffee
11	102°	...	...	36	516	"	34·160	
12	97·5	...	1	33	521	"	38·520	Do. castor oil
13	97·5	...	1	31	519	"	36·190	No medicine
14	...	...	...	27½	526	"	39·400	"
15	96°	...	...	27½	526	"	39·400	"
16	...	...	...	21	516	"	...	"
17	96°	...	...	30	531	"	...	"
18	...	...	1	50½	507	Increasing	38·50	"
19	...	...	1	46	418	"	...	"
20	...	...	1	24½	344	...	...	"
21	98°	...	1	32	336	...	...	"
22	...	...	1	39	401	...	...	"
23	...	...	1	40	459	173·31	...	"
24	...	...	1	56½	432	162·12	44·03	"
25	...	...	1	60	488	172·31	49·60	"
26	...	...	1	46	...	165·05	37·14	"

In this case, therefore, 1 kilogramme of body-weight excreted during twenty-four hours:

	Urea.	SO_3.	Water.
	Grammes	Grammes	c.c.
On the 8th and 9th days of the febrile period (average excess of temp., 5° Fah.)	0·588	0·042	13
In the period of complete convalescence, 24th and 25th days, good diet ...	0·507	0·052	29

[2] Monthly Journal (Edin.) of Med. Science, 1854, p. 235.

coloured. It is singular enough there should be any doubt on so simple a point.

Abnormal constituents.

It would seem that the urine in typhus is much more frequently albuminous than in typhoid fever. Dr. Edwards[1] found the urine in fourteen cases, examined before the eighteenth day, to be always albuminous. In six cases, examined after the twentieth day, there was no albumen.

Oppolzer[2] noticed albumen in most cases, and sometimes cylinders; the amount of albumen was often as great as in Bright's disease. On the other hand, Wunderlich found albumen only in four out of forty-nine cases of exanthematic typhus.

Dr. Sidey[3] noticed albumen "in a very large proportion of cases" in Edinburgh; it occurred invariably towards the crisis of the fever, and in many cases on the sixteenth day of the disease. It continued for four or five days.

Possibly in typhus, ammoniacal compound may be present, underived from decomposition of the urea in the bladder or after emission. But at present this has not been proved satisfactorily.

SECTION VI.

RELAPSING FEVER.

The last epidemic of relapsing fever in this country occurred before the employment of the volumetric means of analysing urine. Scarcely anything definite is therefore known on the subject. Before the "crisis" the urine is high coloured; it often contains bile-pigment, but is seldom albuminous or bloody.[4] At the crisis when the temperature falls suddenly, and there is great sweating, the urine often also increases greatly and suddenly in amount. In the first stage, the uric acid is increased, and probably the urea also; the condition of the chlorides, sulphates and phosphates is uncertain.

In some bad cases of relapsing fever, there is more or less non-excretion (without albuminuria?), and symptoms of urinæmia and cholæmia.[5]

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[1] Monthly Journal (Edin.) of Med. Science, 1854, p. 255.

[2] Schmidt's Jahrb., 1857, No. 11, p. 256. It is assumed that typhus exanthematicus is spoken of.

[3] Begbie, in B. and F. Med.-Chir. Rev., July, 1853, p. 59.

[4] Griesinger, Virchow's Handb., Band ii, p. 216.

[5] Vide the Treatises of Cormack and Wardell on this point.

SECTION VII.

VARIOLA.

Normal constituents.

In small-pox the urine presents the ordinary febrile characters of lessened quantity and heightened colour. The diminution in the urine lasts in bad cases till the eleventh or twelfth days.

1. The urea is increased when the temperature is high. Moos noted 33 grammes or 509 grains in twenty-four hours while the patient was on fever diet while in a case with scarcely any rise in temperature, the amount was only 22 grammes or 339 grains.

2. The uric acid is increased, and sediments of urates occur throughout, either spontaneously or on the addition of an acid.

3. The amount of the chlorides is not known; in two cases I found them lessened, but, perhaps, not in a greater degree than the meager diet would account for.

4. The sulphuric acid is either at, or a little below, the healthy amount; the influence of food being taken into account, it may be considered as being a little increased. In one of my cases (a man) it averaged 25·27 grains on the seventh and eighth day; in another (a woman) it amounted to 19 grains in each twenty-four hours; both cases were confluent and severe.

5. The exact amount of the phosphates, pigment, and extractives, is uncertain, but the pigment is certainly increased.

Abnormal constituents.

Albumen is often present at the height of the disease, but is temporary; I observed it in two out of five cases, once with a little blood; Martin Solon in five out of eleven cases; Becquerel in one out of eleven cases;[1] if added together these cases give a proportion of 29·6 per cent. It sometimes appears at the onset of a very severe case, and then disappears. Bile-pigment is very frequently present—a fact first noticed by Schonlein.

Leucin and Tyrosin could not be found by Hoppe;[2] Frerichs, however, detected them in one case.

In malignant small-pox, the urine contains blood or dissolved hæmatin. In very severe confluent, but not specially malignant cases, blood often appears in slight, and sometimes in large amount. Renal cylinders are not uncommon.

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[1] Simon's Chemistry, by Day, vol. ii, p. 282.

[2] Deutsche Klinik, 1858, No. 51.

The bladder is affected in a great number of cases, and there is increased mucus. If the urine be retained in torpid and semi-comatose cases, it becomes soon ammoniacal, as in all cases with catarrhal cystitis. It is probably in these cases that the sulphuretted hydrogen noted by Chevallier, Höfle, and Heller, is found.

SECTION VIII.

In varicella the urine is usually little affected; Schonlein states that in the early stages it is often as limpid as in hysteria.[1] When the fever runs high, it assumes the usual febrile characters (Becquerel).

SECTION IX.

RUBEOLA.

In measles, few analyses have been made. Brattler noticed in a man, aged twenty-five, on the second, third, and fourth days of eruption, temperature 102° Fah. (diarrhœa present), 945, 580, and 945 c.c. of urine; 51·975, 33·66, and 51 grammes of urea; none, 0·348 grammes, and no ClNa; and 2·44, 1·16, and 1·89 grammes PO_5. On fever-free days, after disappearance of the eruption, the man excreted 410 c.c. urine: 18·56 grammes urea; 2·87 grammes ClN, and 0·82 PO_5. Aceton ($C_6H_6O_2$) was discovered in the urine of one patient by Petters.[2]

Albuminous urine is extremely common in some epidemics, and appears simultaneously with the eruption;[3] it then may disappear and reappear at the period of fading of the rash. Blood in small quantities is common. In the Leith epidemic of 1854, the recoveries were most speedy when the albuminuria was greatest.

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[1] Simon's Chemistry, by Day, vol. ii, p. 282.

[2] Meissner's Report on Phys. for 1857; Henle's Zeits., Band iii, p. 311.

[3] Brown, On the Epidemic Measles of 1854, in Leith (Monthly Journal, April, 1855).

SECTION X.

SCARLATINA.

Normal constituents.

In scarlet-fever the urine has the ordinary febrile characters. During the first six days the amount is small; the urea and uric acid are increased in amount, and sediments of urates occur. In a girl, aged thirteen, Uhle[1] found the urea greatly increased, each kilogramme of weight excreted 0·677 in twenty-four hours; during convalescence only 0·486. Brattler gives a case in a man, aged twenty-four, who passed 41 grammes of urea during the fever; 42 in defervescence; only 23 in convalescence. The chlorine is sometimes greatly lessened (Brattler), and augments in convalescence. The amounts of sulphuric and phosphoric acids are not known. On the sixth to the eighth day, if the case goes on well, the urine becomes abundant, pale, and the reaction is neutral or feebly acid.

Abnormal constituents.

According to Holder's examination of seventeen cases, there is bile-pigment during the first six days.[2]

The urine is especially affected in scarlatina, from the very frequent, if not invariable, implication of the kidneys and bladder. It becomes albuminous in a large proportion of cases, though not in all. Dr. Warburton Begbie, who first drew attention pointedly to the extraordinary frequency of albuminuria, believes it to be present at some period in almost every case.[3] From the observations of the majority of observers, there can be little doubt that it is most common after the sixth day, and during desquamation. In seventeen cases, Holder never found it before the sixth day; it then appeared in every case, and lasted for three to nine days. It is usually associated with a large amount of renal, pelvic, and bladder epithelium, but not with renal cylinders (Begbie), unless there be dropsy.

The exact proportion of cases in which albuminuria occurs during desquamation, is uncertain, and the statements are so discordant as to have led to the belief that the proportion varies in different epidemics, or even in different periods of the same epidemic, or that it may be affected by treatment. It is, however, highly desirable that this subject should be again investigated.

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[1] Schmidt's Jahr., 1859, No. 10, p. 12.

[2] Schmidt's Jahrb., 1856, No. 7, p. 88.

[3] See his papers in the Monthly Journal, 1852; and in the British and Foreign Medico-Chirurgical Review, July, 1853, p. 52.

In addition to albuminuria, the desquamation of the kidney and bladder epithelium produces, in many cases, a tendency to the early decomposition of the urea, and of course to alkalinity and deposition of the phosphates. In malignant scarlatina, as in malignant variola, there may be considerable hæmaturia or passage of dissolved hæmatin.

Albuminuria occurring during desquamation is usually transient, but it may continue until an attack of dropsy occurs. Sometimes the albumen totally disappears, and reappears when dropsy comes on a fortnight or three weeks later.

In scarlatinal dropsy, almost, if not all, the evidence adduced in this country would show that albuminuria, with blood, renal epithelium, and cylinders, is an invariable accompaniment. In fact, scarlatinal dropsy is very generally considered as most intimately connected with the kidney disease. When the kidney disease is well marked, the characters of the urine exactly resemble those in the so-called acute Bright's disease, and will be described in a future section.

It has been stated, however, both by Simon[1] and Becquerel,[2] that scarlatinal dropsy can occur without albuminuria. Becquerel states that these " cases are not very uncommon," and depend on a diminution of the quantity of albumen in the blood; he makes therefore two varieties of scarlatinal dropsy; one with, the other without, albuminous urine. Philipp of Berlin[3] appears to have often met with dropsy without albuminuria, and Rilliet and Barthez[4] certify to the same fact, and quote from Noirot an assertion, that albumen is wanting in one third of the cases of scarlatinal dropsy. Rayer,[5] moreover, refers to similar cases of which he had knowledge.

Possibly, as observed by Legendre, some of this discrepancy may arise from the urine not being examined throughout the whole dropsical period, but merely perhaps once or twice, towards its end, when the albuminuria may have disappeared. It seems, however, hardly likely that all the negative cases can be so explained; and at present the evidence is decidedly in favour of the opinion that albuminuria may be wanting in scarlatinal dropsy.[6]

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[1] Day's Translation, vol. ii, p. 279.

[2] Traité de Chimie Pathologique, 1854, p. 343.

[3] Simon's Chemistry, by Day, vol. ii, p. 280.

[4] Traité des Maladies des Enfants, 2d edit., 1854, vol. iii, p. 179.

[5] Malad. des Reins, 1841, tome ii, p. 446.

[6] On the microscopic characters of the urinary sediments in dropsy, see Tripe's Essay in the British and Foreign Med.-Chir. Review, Jan. 1854. The large cells referred to by him at page 244 were no doubt epithelial cells from the pelvis.

SECTION XI.

ERYSIPELAS (IDIOPATHIC).

Normal constituents.

In erysipelas of the head and face, the urine has the ordinary febrile character, although it is often not very strongly marked. In a man aged twenty, on the fifth and sixth days of the disease, I found the water averaged, in each 24 hours, 26¼ oz. (821 c.c.); the solids, 636 grains; the chlorine, 19 grains; the SO_3, 28·74 grains; the uric acid, 4·38 grains. Although the urea was not determined, yet, as the chloride of sodium was diminished, and as, considering the starving diet, the amount of solids was greater than natural, it follows that the urea or the extractives must have been augmented. The SO_3 may be perhaps considered to be very slightly increased, as during convalescence, on good diet, the amount was 26 grains. The only point of interest is the fact that the uric acid, which is so very generally greatly augmented in the pyrexiæ, was not so here; possibly it may have been naturally small in amount in this man during convalescence; indeed it then amounted to only 0·707 grains in twenty-four hours. Whether, then, it was a peculiarity of this case, or whether erysipelas of the head and face does not augment the uric acid so much as other fevers, must be left undecided. The chlorine augmented at the commencement of convalescence, although the diet was not altered, rose from 19 grains on the fourth day, to 36 grains on the ninth. In another case, the chlorine was entirely absent, although the man was taking tinct. of the sesquichloride of iron. Chloride of sodium, also (ʒij), given by the mouth, did not pass off by the urine for two days, so that there was most decided retention. Sediments of urates occur in erysipelas, as in other cases, and own the same causes.

Abnormal constituents.

Temporary albuminuria occurs now and then in this, as in all other fevers; the ratio of the occurrence is not known.

Effect of remedies.—The only observation I am acquainted with is one made by myself. In the case just referred to, the patient commenced liquor potassæ (Pharm. Lond.) in doses of ʒv. in twenty-four hours, on the seventh day of the disease. He took no other medicine, and the diet was the same. The only disturbing effect was the progress of the disease, which commenced to decline on the eighth day, and was quite gone on the tenth.

Mean excretion in twenty-four hours.

	Quantity.	Solids.[1]	Uric acid.[2]	SO_3.[3]	Cl.[4]
	Ozs.	Grains	Grains	Grains	Grains
On 5th and 6th days ..	26½	636	4·38	28·74	19·2
On 7—11th days inclusive: ℥ijss of liq. pot. during this time ...	47	704	1·97	28·64	31·1
On 10—12th days inclusive: no medicine, good diet	41	617	0·707	26·41	...

In this case, as in so many other acute diseases, the effect of the remedy is very much obscured by the natural course of the disease. On the day after the liquor potassæ was commenced, the redness and swelling of the face began to decline, and was gone in two days. Still, it can scarcely be doubted that as the solids, which would probably have fallen in amount on account of the cessation of the fever, were augmented; and this was only in part due to the reappearance of the chlorides, the organic compounds were increased. The sulphuric acid also must have been increased by the liquor potassæ; for, as the man was on the same low diet, it would have fallen during convalescence rapidly, had no medicine been given. Afterwards, from the twelfth to twentieth days, when the man was quite well, and plenty of food was taken, the sulphuric acid was below the amount of the febrile and convalescent periods.

The uric acid fell rapidly, even during the time that the liquor potassæ was given.

SECTION XII.

PYÆMIA AND SEPTICÆMIA.

In those diseases which are caused by the rapid absorption into the blood of unhealthy and probably rapidly decomposing organic substances, and which are attended in certain cases with the formation of multiple abscesses, few analyses have been yet made. The urine is very scanty, very dark, contains often bile pigment, and sometimes blood or dissolved hæmatin.

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[1] The solids were determined on the fourth, fifth, sixth, tenth, eleventh, twelfth, fifteenth, and nineteenth days.

[2] The uric acid was determined on the fourth, fifth, sixth, tenth, and thirteenth days.

[3] The SO_3 was determined every day.

[4] One observation on the fifth, and one on the tenth day.

1. The amount of urea has been found very much increased by Alfred Vogel;[1] on one day it amounted to no less than 80 grammes, or 1235 grains. On this point, see also p. 177, where a case of pyæmia is noticed. The chloride of sodium was diminished.

2. I have determined the amount of sulphuric acid in a case of confluent small-pox, occurring in a man soon after amputation. The small-pox ran its course well till the eleventh day, when there was shivering; on the following day there was bilious vomiting; on the fourteenth day there was sudden pain in the right wrist, and swelling of many joints; on the following day there were all the marked symptoms of pyæmia. After death, the joints were full of pus. The amount of the SO_3 was as follows:

		SO_3. Grains.
7th	day (eruption very copious)	23·820
8th	,,	26·728
12th	,, (commencement of pyæmia on the previous day)	25·116
13th	,,	36·216
14th	,, (joint pain)	38·430
15th	,, ,,	48·555
16th	,, (jaundice)	41·450
17th	,, (sinking—died next day)	44·467

As the diet was extremely scanty during the whole of this time, and no medicine likely to cause increase of the SO_3 was taken,[2] the increase of this substance during the progress of the disease, and especially after the joints became affected, is very remarkable.

SECTION XIII.

DIPHTHERIA.

Normal constituents.

Scarcely any analyses have yet been made. Dr. Sanderson, in his very able paper[3] on diphtheria, endeavoured to determine the amount of urea, but he informs me that he found great difficulty in getting rid of the albumen; so that he does not look upon the analyses as sufficient. The urea seemed to be much increased.

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[1] Zeitsch. für rat. Med. (N. F.), Band iv, p. 362.

[2] Ammonia, ether, wine. A little liq. pot. had been given on the fifth and sixth days.

[3] British and Foreign Medico-Chirurgical Review, Jan. 1860.

Abnormal constituents.

Albumen is found in many cases; 50 per cent. (Lee), 66 per cent. (Bouchut and Empir), in the majority (Mangin). Its quantity appears to be sometimes enormous, so that the urine becomes quite solid from heat and nitric acid.

Sanderson also noticed albuminuria in his cases. Hervieux[1] considers it to be merely an epiphenomenon, and not necessary; this is, of course, true, since some cases occur without albuminuria; but albuminuria is clearly a most important symptom, both as connected with the pathology of the disease and its prognosis.

SECTION XIV.

PUERPERAL FEVER.

The amount of urea has not been determined.

Chiari[2] found the pigment increased; there was also bile-pigment; there were no constant changes in the sulphates or phosphates; the chlorides were lessened, and, after some days, disappeared altogether.

Albumen was found by Kerschensteiner[3] in two thirds of all cases; it was most frequent in the severe cases.

SECTION XV.

MILK FEVER—MASTITIS.

It is stated by Heller[4] that there is often a great increase in the amount of the urine, which is highly saccharine, and almost always albuminous; the urea, uric acid, sulphuric acid, and pigment are increased: the chlorides lessened. I am not aware of any other observations on the urea and uric acid, but there are several statements confirmatory of the presence of sugar.

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[1] De la Diphtherie. Paris, 1860.

[2] Klinik der Geburtshilfe, von J. Chiari, Braun, and Spaeth. Erlangen, 1855, p. 515.

[3] Henle's Zeitsch., 1859, Band v, p. 169.

[4] Archiv für path. Chimie, 1853, p. 446. The determinations were only per-centage amounts.

SECTION XVI.

ACUTE DISEASES OF THE NERVOUS SYSTEM.

The examination of the urine in this class of diseases is at present most imperfect; chiefly from the difficulty of collecting all that is passed. In meningitis the urea was found increased by Moos (1041·2 grammes = 636 grains in 24 hours), the chloride of sodium was lessened.[1]

Tomowitz asserts that in meningitis the chloride of sodium is not diminished;[2] and that the phosphoric acid is much increased. This last statement is confirmatory of that made previously to the same effect by Dr. Bence Jones,[3] but in both cases the conclusions are based merely upon per-centage analyses.

In delirium tremens, Dr. Bence Jones found the phosphoric acid remarkably decreased, while the sulphuric acid was often increased.[4]

In mania, Dr. Alexander Sutherland[5] found the phosphoric acid increased during the paroxysms, and lessened on the exhaustion following acute mania, in acute dementia, and in the third stage of paralysis of the insane.

Unfortunately, here also the analyses do not give the amount excreted in twenty-four hours, but merely the relative amount compared with the water and with the other solids. Judging from this last condition, however, Sutherland's statement seems extremely probable.

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[1] There may, however, be some doubt about the diagnosis of this case.

[2] Zeitsch. der Wien Aerzte, 1851, Oct. and Nov.

[3] Philosophical Trans., 1847, p. 449; viz., that the phosphates are increased in acute affections of the nervous substance.

[4] Ibid. It must be said, however, that the analyses here also merely give the per-centage, *i. e.* the relative, not the absolute, amount. Some doubt must therefore still exist.

[5] Medico-Chirurgical Transactions, vol. xxxviii.

SECTION XVII.

ACUTE DISEASES OF THE THORACIC ORGANS.

1. *Acute Lobar Pneumonia.*

Normal constituents.

1. It is a matter of daily experience that the amount of water is lessened in acute pneumonia. The extent of the lessening is one third to one half, the average excretion being about 600 to 800 c.c. in twenty-four hours instead of 1200 to 1500. This is most marked during the early days; during the stage of complete resolution the amount increases, and sometimes surpasses the normal amount, though this is not so marked as in typhoid fever.

This diminution is not dependent on lessened ingress of water, as patients often drink largely; it may be partly attributable to increased action of the skin, as profuse sweats are usual in pneumonia after the third day. It is doubtful whether it can be altogether so accounted for; and as the same diminution is found in those cases in which there is no sweating and no purging, it must be presumed that, (unless we are prepared to believe that there is an immense excretion of watery vapour from the lungs), there is retention of water in the body.

The relation of the amount of water to febrile heat is not certain. The determination would require hourly observations, with full attention to the amount of water drunk, and to the action of the skin. But if, as frequent in pneumonia, the pyrexia ends suddenly (within twenty-four or thirty-six hours)[1] the amount of water is usually increased on the following day.

2. *The urea.*—That the urea is increased during the height of the disease in many cases, is quite certain, as the amount of increase is much beyond the maximum physiological limit (see Introduction to 1st book, p. 7).

The following table shows this.

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[1] The term "defervescence" is used in these pages occasionally; it is adopted from Wunderlich, and signifies that period in which the temperature is declining to its normal amount from the intense degree it had attained in the stage of accession. Defervescence may be sudden (by crisis), or be gradual (by lysis), or partly sudden and then slow; or it may occur in a way, I believe, I pointed out, viz., in a wave-like manner, with gradual and often regular alternations of high and low temperature.

In acute pneumonia in adults, during the height of the disease —usually on fourth to eighth or tenth day.

Amount of urea in 24 hours.		Authority.
Grammes	Grains	
33·45	516	Brattler: mean of the 2d — 7th days inclusive, in a man aged 40, on the 8th day (fever gone) the amount was 21·6 grains
37·65	576	Moos[1]
38·75	597	Alfred Vogel[2]
43·00	664	Wachsmuth[3]
53·00	818	Author: in a woman aged 20
53·80	830	Zimmerman[4]
55·00	850	Author: in a man aged 22, on the 5th day of disease
55·84	862	Brattler:[5] in a man aged 23
68·40	1056	Metzger
70·00	1080	Professor Julius Vogel[6]
70·00	1080	Zimmerman[7]
85·56	1321	Author: in a man aged 22,[8] on the 6th day, weight 63·6 kilogrammes (1 day's observation)

Now these numbers are so much beyond the limits of health, that no doubt can exist of the great increase in the urea. Unfortunately the age and weight of all the patients are not given. But the immense excretion of urea is shown by my last case.

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[1] Henle's Zeitsch., 1854, Band iv, p. 362.

[2] Ibid., Band vii, p. 291.

[3] De Ureâ in morbis febrilis acutis. Inaug. Diss., Berol, 1855. Reviewed in Canstatt's Jahresb., by Scherer, 1855, p. 71.

[4] Hamernyk's Report, in Canstatt's Jahresb. for 1852, p. 223.

[5] Ein Beitrag zur Urologie, p. 39. I have taken the mean of the fourth, fifth, sixth, eighth, twelfth, and thirteenth days. On the intermediate days, the urine was lost. In five other days—fourteen to nineteen—the mean amount was 29·22 grammes, or 451 grains.

[6] Henle's Zeits., 1858, Band iv, p. 202.

[7] Neubauer's Anleitung, 3d edit., p. 319.

[8] The analysis was made by my clinical clerk, Mr. E. Smith, and may be relied on. See Medical Times and Gazette, Feb. 1860.

Pneumonia in a man aged twenty-two. Mean temperature before defervescence, 104° *Fah.*

Day of disease.	Condition of patient.	Amount of urine in 24 hours, in c.c.	Urea in 24 hours, in grammes.	Chloride of sodium in 24 hours, in grammes.	1 kilogramme of body weight excreted in 24 hours of urea in grammes.
Part of 6th and 7th days	First day of defervescence, temp. 100·6° Fah.	980	85·56 (= 1321 grains)	None.	1·345
Part of 7th and 8th .	Temp. 98·6° F. Complete defervescence	...	...	...	...
Part of 8th and 9th .	Complete defervescence. Absorption of exudation	865	87·38 (b) (= 1349 grains)	...	1·373
Part of 9th and 10th.	„	865	87·38 (= 1349 grains)	...	1·373
Part of 10th and 11th.	„	...	...	Some, amount unknown. 0·040 grms. in 10 c.c.	...
Part of 13th and 14th.	Complete convalescence. Exudation gone	1300	35·1 (= 542 grains)	5·2 (= 80 grains)	0·551
Part of 20th and 21st.	„	1297	30·2 (= 466 grains)	17·18 (= 265 grains)	0·474
Part of 21st and 22d .	„	1760	44·0 (= 679 grains)	21·95 (= 339 grains)	0·691
Part of 23d and 24th.	„	1910	40·1 (= 619 grains)	14·32 (= 221 grains)	0·630
Mean excretion of urea by 1 kilogramme of body weight on the 7th, 9th, and 10th days, during resolution					1·363
Ditto, ditto, during the 14th, 21st, 22d, and 24th days complete convalescence					0·586
Mean physiological excretion in men aged twenty-two ...					0·500

This immense excretion is not dependent on food, for little food is usually taken, and my last patient was starving for several days; nor can it be thought to be dependent on the water-drinking (for when water eliminates urea, it passes off itself at the same time) nor on movement. It is evidently unconnected with any of the physiological causes, and, as in other diseases, must be dependent on the pyrexia.

The excretion of urea is supposed by Zimmermann to be greatest on the so-called critical days. Metzger found it largest on the sixth day, in four out of nine cases; in the other cases it was largest on the fifth, eighth, ninth, thirteenth, and seventeenth days. In two cases in which it was examined on the second and third days, the amount of urea was small, but it rapidly augmented on the following days.

Wachsmuth has proved conclusively that, in equal periods, the excretion is more abundant during the day than during the night. This arises partly, no doubt, from more food being given during the day, and partly, perhaps, from the temperature rising all day to the evening, and falling during the night, as is usually the case in typical cases of pneumonia.

Vogel, Moos, and Wachsmuth, all agree that the urea is in larger quantity *before* than *during* resolution. The following case from Moos illustrates this:

	Water.	Urea.	ClNa.
	c.c.	Grammes.	Grammes.
On each of three days before resolution	926	37·65	0·25
On each of seven days during resolution	1073	21·16	7·9

Metzger gives the fourteenth day as that on which the urea returns to its usual amount. I have, however, found the excretion to be sometimes very great during resolution, after the pyrexia has almost disappeared (50 to 60 grammes), and I think there must be some difficulty in determining the exact time when resolution (*i. e.* absorption of exudation) commences. But the general fact must be admitted, that the greatest amount of urea coincides with the highest temperature, and that it arises from general increased metamorphosis. During resolution, when the temperature may be as low as in health, and yet the urea may be still in large amount, the urea may either arise from absorption and metamorphosis of the exudation, or it may have formed some time before, but retained until a later period.

The observations are not yet numerous enough to determine whether the amount of urea is as intimately connected with the temperature in pneumonia as in ague.

The specific gravity of the urine in pneumonia is high (1025—1035), partly from the deficiency of water, partly from the excess of urea. As ClNa is absent, the specific gravity measures pretty accurately the amount of urea.

3. *Uric acid.*—As in most febrile diseases, uric acid is in-

creased. Zimmermann has recorded a case in which no less than 29½ grains were passed in twenty-four hours; an enormous amount. Usually it is less than this, ranging from 12 to 20 grains (0·800 to 1·2 grammes). Occasionally, however, it is not much increased till resolution. In a patient of mine, Dr. Ranke found on the fifth and sixth days 0·468 and 0·480 grammes, while on the tenth day, when resolution was going on, there were 1·210 grammes, or 18⅓ grains, in twenty-four hours. The daily excretion during complete convalescence in this man was only 0·209 grammes, or 3 grains. The cause of this variation is probably to be found, not in any difference of formation in the several cases, but in the fact that uric acid is not, like the diffusible urea, almost always at once got rid of, when formed. It is often retained for some time in organs or in the blood, and is afterwards discharged in large quantities. It is probably *formed* largely during the early intense febrile period, but is *eliminated*, it may be subsequently. Certainly, it is especially during the latter febrile period, and in early convalescence, that those immense deposits of urates occur, which indicate a very large amount. In eighteen cases, Metzger noticed sediments to occur—

2	on the	3d day.	2	on the	8th day.
1	„	4th „	2	„	9th „
1	„	5th „	2	„	12th „
1	„	6th „	4	„	13th „
3	„	7th „			

That these deposits of urates are a favorable sign there can be little doubt, though Dietl has affirmed that cases without any deposit run the most favorable course. The causes of the deposit of urates consist in lessening of water, absolute excess of uric acid, and in all probability in an increase in acidity after emission. When no deposit occurs, a drop of acid will often throw down a great cloud of urates and amorphous uric acid. The composition of the urate sediments in pneumonia is the same as in other cases.

The relative increase of uric acid, as compared with urea, has not been settled, but it is likely that uric acid is relatively in greater amount.

4. Hippuric acid is stated by Weissmann[1] to be lessened. The observation is very imperfect, and the influence of the diet has not been sufficiently considered.

5. The pigment is increased or altered, and tints the urates, when they fall, brown, red, or carmine. The extent of the in-

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[1] Henle's Zeitsch., 1858, Band ii, p. 339.

crease of pigment and extractives is not known. Vogel's method gives an increase of two or three fold; and Simon's analyses also indicate that the increase is considerable.[1] Uroxanthin (indican) is uncommon.

6. The ClNa is diminished, or is entirely absent, during the early period and at the commencement of hepatization, and reappears during or rather after resolution.[2] This seems to be an almost invariable occurrence; at least, very few exceptional cases have yet been recorded. The chloride of sodium does not, however, reappear directly resolution commences; it may still be retained for some days (even as many as eight or ten). It is then poured out in such quantities (15 to 25 grammes in twenty-four hours), in cases where there is little expectoration and no purging, as sometimes to raise the specific gravity of the urine, although the water is increasing and the urea is diminishing. The period of its increase is, therefore, some time after the ureal excretion has reached its acme, and is declining.

This great excretion during convalescence proves that the chlorine has been retained, and not excreted in excess through the skin. Beale's observations, in fact, prove that the lung-exudation is very rich in chlorides, and it is often largely excreted in the sputa.

7. Heller has stated that the sulphuric acid is increased in pneumonia. Lehmann, from the observation of two cases, was led to doubt this; and, certainly, Heller's analyses did not indicate the quantity of SO_3 excreted in twenty-four hours, but merely the per-centage amount. Gruner also observed only 0·72 grammes, or 11 grains, excreted in twenty-four hours (mean of five days). It is, however, a fact that the SO_3 is often very considerably increased. In a girl, aged nineteen, who was on starving diet, I found on the fifth day of the disease 2·44 grammes, or 37·73 grains, excreted in twenty-four hours, which was certainly one third at least over the healthy standard of this person. In a man, aged twenty-two, the excretion about the eighth or tenth day of disease averaged 58·8 grains, or 3·8 grammes, in each twenty-four hours; no food having been taken for several days.

Professor Vogel also mentions several cases in which it was increased; and, in one instance, no less than 4·4 grammes, or 69·9 grains, were excreted on the day before death. When the SO_3 is increased, the urea is so likewise, and there is a general though not a very close correspondence between their amounts.

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[1] Simon's Chemistry, by Day, vol. ii, p. 217.

[2] Heller, Redtenbacher (in 80 cases), Beale. Redtenbacher states that no chlorine appears in the urine, even when hydrochloric acid is taken (Canstatt's Jahresberichte for 1850; Löbel's Report, p. 254); and Howitz affirms the same of the chloride of sodium. I can confirm this. I have given chloride of sodium (ʒii) in the early stage, and could find none in the urine subsequently.

There are, however, cases in which the SO_3 is not increased, but they must be regarded as exceptional. Some instances of this kind will be presently referred to.

8. The phosphoric acid is lessened, necessarily, by the scanty diet. In two analyses I found it, however, to be lessened even below this point. Professor Vogel[1] also noticed, in one case, on an average of eight days, only 1·47 grammes, or 22·69 grains, during the height of the disease, or, in another case, 1·82 grammes, or 28 grains, on an average of five days; while Vogel's healthy average for men is 3·5 grammes, or 54 grains: the excretion of phosphoric acid would therefore appear to have been remarkably diminished. Additional observations are, however, necessary. Vogel refers to one case in which it was increased. Heller believes, that in all inflammatory affection the phosphates are increased;[2] but this opinion, drawn merely from per-centage determinations, is very doubtful.

9. The free acidity in pneumonia appears, from Vogel's observation,[3] to be lessened. The acidity to test-paper seems always very great, but this may be simply owing to the concentration of the urine.

Abnormal constituents.

Abnormal products are found in many cases. 1. Pettenkofer observed, that the bile acids are often present, though they are not constant.[4] Bile pigment is very common, even without jaundice, though slight jaundice (especially in pneumonia of the right lung) is not infrequently seen. 2. Leucin and tyrosin have not yet been detected. 3. Albumen is present in a large proportion of cases. It occurred in no less than fifteen out of thirty-three cases, noted by Finger, or at the rate of 45·4 per cent. Becquerel[5] noticed it in nine of twenty-one cases, or in 42·8 per cent. I found it in six of thirteen cases, or in 46·1 per cent. It occurred, therefore, nearly equally often in Vienna, Paris, and London. Adding all the cases together, we have thirty instances of albuminuria among sixty-seven pneumonic cases, or at the rate of nearly 45 per cent. Some observers have found it even more frequently. On the other hand, Metzger (loc. cit., p. 202) did not find it once in forty-eight cases. No explanation can be given of this discrepancy. The period of its occurrence is variable. It is generally said to be most common at the commencement of, and during resolution; and it has been supposed that some of the absorbed exudation is got rid of in this way.[1] According to Heller,[2] the albumen appears at the time when the chlorides are most deficient, viz., as hepatization advances. I have not been able to trace any special connection between the presence of albumen and the absence of chlorides; but, certainly, my observations accord with Heller's statement, that it is during the height of the disease that albuminous urine is most frequent. While, in one case the albuminuria appeared during resolution, in no less than five of my six cases it occurred during the very height of the disease, and when resolution (as that term is usually understood) had not apparently commenced. In one case there were, at intervals of from six to eight weeks, three recurrent attacks of acute pneumonic consolidation affecting different parts of the two lungs, and, at the height of each attack, albuminuria occurred, while in the intervals, and subsequently, the urine was quite free. It was not, then, during resolution, but before it, when the lungs were commencing to be consolidated, that albuminuria most frequently occurred in these cases; and it must be referred, not to absorbed exudation passing out by the urine, but to the implication of the kidneys in the general congestion and exudation, the most marked local seat of which was in the lungs. Of the five cases in which albuminuria occurred during the height of the disease, no less than three died; while, among my seven non-albuminous cases, there was only one death. While the mortality of all the cases was four in thirteen cases, or 30·7 per cent., that of the cases with albuminous urine was 50 per cent., and with non-albuminous urine was 14 per cent.[3] Therefore, albuminuria occurring before resolution appears to be, by my cases, an unfavorable sign.[4] In the fifteen cases in which Finger found albuminous urine, six died, or at the rate of 46 per cent., but the period at which the albumen occurred is not stated.

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[1] Neubauer's Anleitung, 2d edit., p. 270.

[2] See Dr. Moore's work, entitled Heller's Pathological Chemistry of the Urine. Dublin, 1855, p. 58.

[3] Neubauer's Anleitung, 2d edit., p. 251.

[4] Quoted by Lehmann, Handb. der phys. Chem., 1854, p. 190.

[5] Traité de Chim. Pathol., 1854, p. 347.

The very frequent occurrence of albuminuria in sthenic pneumonia is one of the most interesting facts in its clinical history; in no disease seen in this country, except perhaps in maculated typhus, is it so common. Bronchitis of the large tubes, chronic phthisis, and emphysema, present a most marked contrast to pneumonia in this respect.

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[1] See especially Begbie, Brit. and For. Med.-Chir. Rev., July, 1853, p. 56.

[2] Archiv für path. Chem., N. F., 1852, p. 282.

[3] The average age of my cases with albuminuria was twenty-five years; of the non-albuminous cases, thirty-seven years. The ages of the fatal cases with albuminuria were twenty-seven, twenty-five, and seventeen years; of the fatal case without albuminuria, thirty-four years. Is albuminuria more common among the younger persons attacked with pneumonia?

[4] Heller (loc. cit., p. 283) says, that the longer the chlorides continue absent and the albumen present, the more severe is the case.

The albuminuria is not invariably connected with extent of local disease, or with great impediment to circulation or respiration; cases of enormous consolidation, and with great dyspnœa, have not necessarily albuminous urine.

4. Renal cylinders are very common in the albuminous urine of pneumonia. A little blood is also frequent, but it is usually out of all proportion to the albumen.

5. Heller[1] relates a case in which hydrosulphate, hydrochlorate, and carbonate of ammonia were contained in urine which was slightly albuminous.

6. Zimmermann[2] has noticed fibrin in the urine of the third day of pneumonia; and Shearman, in a chlorotic girl, found abundance of cystin.

7. In all cases, but especially in women (Becquerel), the mucus of the bladder is increased, and there is an increased tendency to ureal decomposition, and to urine alkaline from ammonia.

Incidental conditions of the Urine in Pneumonia.

Non-excretion of urinary substances.—In some cases, instead of being increased, the urinary solids are lessened; the urea and the sulphuric acid are much below even the healthy amount; and the uric acid is less than in other cases, though, perhaps, still higher than in health. As this exceptional diminution may occur in intensely febrile cases, with a heightened temperature of five or six degrees, and as it is contrary to what we must assume to be the usual rule in febrile cases, it seems but fair to consider it as a result of retention, and not of lessened formation. This assumption can only be demonstrated by actual analysis of the blood, but it is rendered probable by the following considerations.

1. In such cases, at a later period of the disease, a large amount of some ingredient may be poured out, although the febrile symptoms have almost or entirely gone. Thus, in one of my cases, in which, for some days, the urinary solids were very small in amount, an extraordinary amount of uric acid was passed during the first days of convalescence; it seemed but fair to infer that this had been retained from the previous

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[1] Simon's Chemistry, by Day, vol. ii, p. 218.

[2] Ibid., p. 219.

period of pyrexia, and was not formed at the time when it was excreted. It was, in fact, an example of what the older physicians called crisis by the urine.

2. It is, also, in such cases that, towards convalescence, spontaneous diarrhœa is most likely to come on, as if some morbid matter, retained in the blood, at last found an exit by another eliminating channel. Whereas, in persons with free urinary elimination, such spontaneous discharges are less common.

3. These cases of small excretion of urea, uric and sulphuric acids, do not have such rapid recoveries as patients of an equal febrile state, whose urinary excretion is large. The amount of the urine is, indeed, one of the guides for prognosis; whenever the excretion is small, the cases do not recover so well as when it is large. This fact seems most capable of explanation by the hypothesis that the products of metamorphosis are retained, and poison the blood. The fact is entirely parallel to what is seen in typhoid fever, and in other acute affections.

This non-excretion is not peculiar to the cases with albuminous urine; I have seen it in one patient who had not, throughout, a trace of albuminuria. The cause of the retention is not known; it may be something in the state of kidneys; or, perhaps, the products of the increased tissue-change may not have reached the state of urea and uric acid, or, if they have reached it, may still be in a form of combination ill adapted for traversing the renal vessels.

Convalescence.—During convalescence the urine generally augments considerably in amount, and (cases of previous retention being excluded) the urea, uric and sulphuric acids, fall, for a short period, below their healthy range; the chloride of sodium increases, and an extraordinary amount is sometimes passed; it depends, of course, in some measure, on the quantity got rid of with the sputa, or during the diarrhœa which occasionally comes on.

In the only case in which the observations were sufficiently accurate, I found the increase in the urine, and the fall in the temperature, to be not very closely connected. Thus—

	Average temperature.	Urine in 24 hours.	Chlorine.
		Ounces.	
9th, 10th, and 11th days ...	102·65° Fah.	27	None.
12th—18th days	99·5 „	34	Gradually increasing.
19th—21st days	98 „	63	Large quantity.

Effect of Medicines.—At present, no accurate observations have been made, as the treatment is generally varied; the rapid progress of the disease also renders it almost impossible to assign the exact action of even a single remedy, if only one be used. I have endeavoured to determine the action of mercury and liquor potassæ, but the experiments led to no certain results. In a very acute case, with a temperature of 104° Fah., admitted on the 9th day, slight salivation was produced in twenty-four or thirty-six hours: three urinary ingredients (solids, SO_3, PO_5, and chlorine) happened to be in small amount in this case; they were *not* increased by the mercury.

The carbonated alkalies render the urine alkaline as in health, and increase its amount and its specific gravity.

2. *Acute Pleurisy* (*unconnected with any other diseases*).

Normal constituents.

The urine of pleurisy has the so-called febrile characters, but not usually in any degree approaching to the urine of pneumonia. The water is less diminished, and the organic solids are less increased. Indeed, in some cases in which we can hardly suppose there is retention, the urea and uric acid are very little over the standard of health. In a young man with acute pleurisy of the right side, with moderate fever, who was at first under no treatment, the following amounts were found. I add also the mean quantities during and after the use of liquor potassæ (3¾ drachms, daily), with which medicine alone the case was treated.

In each twenty-four hours.

	Water.	Solids.	Urea.	SO_3.	Chlorine.
	Ounces.	Grains.	Grains.	Grains.	
Three days before treatment	27	418	351	20·8	Abundant.
Seven days: liquor potassæ	48	459	343	22·4	"
Two days: no medicine; convalescence; same diet	40	470	351	22·4	"

When the excretion of the first period, during which the man was suffering from an acute inflammation, attended with effusion of much lymph, though of only a moderate amount of fluid, is compared with that of the last period, it is astonishing how little the metamorphosis of tissue was affected in this patient. The water was lessened, but the urea was the same to a grain, and the SO_3 was little altered. The cause of the slight increase in the solids is not apparent; perhaps the chlorides, though never wanting, may have become increased. Liquor potassæ too, in this case, did certainly *not* increase the amount of urea, and very slightly indeed, if at all, that of the SO_3.

Unfortunately the uric acid was not determined; during convalescence there were abundant sediments of lithates.

Brattler[1] has recorded two cases of pleurisy with exudation, in men aged 28 and 37 years, in which the amount of urea was small; during the height of the disease (spare diet) it ranged from 18 to 24 grammes. The chloride of sodium was from 3 to 8½ grammes, showing that there must have been some food taken; the phosphoric acid was, if anything, lessened.

In both of these cases the temperature was high. In the first case it was for many days 39·5 Cent. (=103° Fah.), in the second case it was 38·5 Cent. (=101·3° Fah.); so that the non-increase of urea was not owing to want of fever.[2] Indeed, if these cases be correct, the rule which seems so clear in ague, and which to a certain extent is probable in typhoid and pneumonia, viz., that the heat of the body, and the excess of formation of the urea, run parallel to the pyrexia, breaks down altogether.

Apparently, then, in spite of the intense pain of simple pleurisy, the effect on tissue metamorphosis is comparatively slight; and this is in accordance with the well-known fact that uncomplicated cases of this disease are not dangerous.

In some cases of pleurisy the chlorides are lessened, or are almost wanting. This appears to be connected with rapid effusion into the pleura;[3] the chloride reappears when the effusion is absorbed.

Abnormal constituents.

Another difference in the urine of pleurisy and pneumonia is shown by the very rare occurrence of albuminuria in the former case. Excluding a case in which there was probably antecedent disease of the kidney, I found very little temporary albuminuria once only in eighteen cases, or in 5·5 per cent.

3. *Acute Bronchitis.*

Normal constituents.

The urine in bronchitis varies greatly, as the grades of the disease are almost infinite, from a very slight affection of the large tubes, to a disease involving all the smaller tubes of both lungs, accompanied perhaps by collapse of the air-cells in some cases, and certainly impeding aëration to a great degree in all. In these last cases the urine resembles that of pneumonia, and the urea is in large amount (39 grammes in a case recorded by Professor Vogel); the pigment is increased; the chloride of sodium is sometimes as deficient as in the height of extensive hepatization.

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[1] Ein Beitrag zur Urologie, 1858, p. 42.

[2] I must remark here, however, that Brattler took the temperature only twice a day. The mean temperature of the day may have been below this.

[3] Howitz, Schmidt's Jahrb., 1857, No. 9, p. 284.

It has appeared to me, however, that those interesting and important cases in which the urinary ingredients are in extremely small amount, because they are retained in the system (if that hypothesis be correct), are more common in severe and general capillary bronchitis than in any other complaint. I have seen two cases in which the excretion was reduced to a very small amount. Thus, a young man, aged nineteen (temp. 100·75° Fah.), during two days, passed in each twenty-four hours only 9½ ounces of urine (294 c.c.), containing only 244 grains of solids, 176 grains of urea, 10·8 grains of SO_3, and no chlorine. There was no albuminuria, and there were no symptoms of uræmia; the urinary excretion gradually increased, and the patient eventually recovered. Moos[1] mentions a case in a girl who passed, during the height of the disease, only 9 grammes of urea, or 139 grains, and 2 grammes of chloride of sodium, while during convalescence she passed 24 grammes of urea, and 11 grammes of chloride of sodium, in each twenty-four hours.

It would indeed seem as if the retention or non-excretion of the urinary substances was more common in diseases attended with considerable impediment to aëration, such as pneumonia and intense capillary bronchitis, than in other affections in which the absorption of oxygen is presumably less interfered with it, although it is neither invariable in these affections, nor is confined to them.

Abnormal constituents.

The urine is frequently albuminous in severe bronchitis, according to Becquerel. Finger noticed it three times in fifteen cases; and I found it in precisely the same proportion, viz. three times in fifteen cases, or 20 per cent., in non-tuberculous cases. It was temporary only.

4. *Pertussis.*

No analyses have, to my knowledge, been yet made. Dr. Gibb[2] has found that sugar in variable quantity is almost always present. Johnston[1] has repeated this observation, and finds it correct.[2]

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[1] Zeitsch. für rat. Med., Band vii, p. 362.

[2] Lancet, 1856.

5. *Acute Pulmonary Phthisis.*

No complete analyses have yet been made, but it has seemed to me that the urinary phenomena very closely resemble those of pneumonia.

The water is lessened, the urea and the pigment are increased, and the chlorides are deficient or absent.

In an emaciated woman with febrile tubercular pneumonia (average temperature 103° Fah., pulse 140, respirations 45), running a course of about four months, with vomicæ in the lung, the mean excretion of urea, on an average of six days, was 36·73 grammes, or 567 grains. As she took no great amount of food, it could not have come from this source. Her weight was not determined, but it was certainly not more than 100 lbs. (say 45 kilogrammes), for she was excessively thin. If this really excessive weight be assigned to her, each kilogramme excreted in twenty-four hours no less than 0·816 grammes of urea (normal amount for women, 0·442 grammes) : the chloride of sodium was absolutely wanting on most days; the greatest amount she ever passed was 1½ grammes. This deficiency was partly owing to spare diet, partly to sweating, to expectoration, and to occasional diarrhœa.

In another case the chlorine was also absolutely wanting, or almost so, throughout the whole course of the disease.

6. *Carditis, Pericarditis, and Endocarditis.*

The exact condition of the urine in pure pericarditis is not known; the febrile pericarditis is almost always associated with rheumatic fever, with pneumonia or pleurisy, with pyæmia, or with some of the specific or diathetic diseases. Traumatic pericarditis is almost the only possible example of a pure disease, and the urine in such a case has not yet been examined.[3]

The same remarks apply, of course, in great measure to endocarditis and to carditis.

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[1] Lancet, 1858.

[2] Gibb used the copper and fermentation test; Johnston, the chromate of potash. It is to be wished that they had isolated the sugar; for so many errors have crept into this subject, that one is inclined to doubt almost all the statements which have been made on the occurrence of small quantities of sugar.

[3] It is not stated whether or not the case mentioned by Simon (Day's edition, vol. ii, p. 209) was rheumatic or not; no mention is made of the joints. The urine was of the intense febrile type, and, as far as can be judged from the analyses (which give only the relative amounts of the constituents), the urea was increased.

SECTION XVIII.

ACUTE DISEASES OF THE ABDOMINAL ORGANS.

1. *Acute Hepatitis.*

Cases of congestion of the liver, passing on to intense hyperæmia and suppuration, are so seldom seen in this country that no analyses of the urine of any value have been made. Some of the older analyses, recorded by Simon and Becquerel, were in complicated or jaundiced cases, and therefore cannot be used. There is no doubt that, in the exquisite forms of hepatitis as witnessed in hot climates, the urine is most highly febrile, and that the pigment is greatly increased. The few observations which have been made, imperfect as they are, show that there must have been an increase in the urea.[1]

When large abscesses have formed in the liver, however, and the functions of great part of the hepatic tissues are abolished, the urea is certainly sometimes deficient. The urine is then copious, pale, non-sedimentous, and non-albuminous.[2] It appeared to me that the want of urea was in proportion to the amount of hepatic tissue destroyed. Lately, A. Heynsius[3] has endeavoured to show, from experiments, that the liver takes an important part in the formation of urea.

Coindet has stated that the urine in hepatitis contains a substance resembling "bilin," instead of urea.[4] Could this have been leucin?

The bile acids were found in the urine in one case, by Gorup-Besanez.[5] Bile pigment is, according to my observations, seldom present unless there is coincident jaundice, which is not invariable, or even very common.

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[1] The observations of Rose (Thomson's Annals of Philosophy, 1815, June, p. 424) are often quoted to prove that the urea is lessened in hepatitis, but those who do so can never have referred to the paper. A case of chronic inflammation of the liver, in a young girl, and "several cases of acute hepatitis" are stated to have shown as complete an absence of urea "as in diabetes mellitus"! But the mode of detecting the urea was by distilling the urine, and adding acid to the liquid which passed over; if it did not effervesce, it was concluded that no urea was present. Rose refers to Henry's plan of forming the nitrate, but he says, "In my search for urea, I have generally chosen the method of distilling the urine, in preference to the more tedious process of evaporation from the extract (p. 426). Add to this very crude method the fact that no symptoms are detailed, and no evidence adduced that the cases were really acute hepatitis (occurring in Scotland), and I think no one is likely to insist on much credit being given to Rose's statements.

[2] Remarks on the Dysentery and Hepatitis of India, by E. A. Parkes, 1846.

[3] Holland, Archiv, Band i, p. 303.

[4] Quoted by Simon, Day's edition, vol. iv, p. 226.

[5] Canstatt's Jahresberichte for 1849. Scherer's Report on Pathol. Chem., p. 41.

2. *Acute Yellow Atrophy.*

In that peculiar febrile disease which is attended by intense jaundice, and is denoted after death by a great destruction of hepatic cells, Frerichs[1] found the urine strongly acid, and containing bile-pigment and bile-acids, but no albumen, or but transitory and slight appearance of it. On standing, a large sediment of pure tyrosin fell—enough indeed to furnish material for many elementary analyses.[2] A large quantity of leucin was dissolved; it crystallized at once, when a drop of urine was put on a slip of glass. There was also present a substance which crystallized like tyrosin, but which contained more nitrogen and was more soluble. The urine contained uric acid in moderate amount, but *urea was entirely absent.* It was in some quantity in the blood. There were no phosphates in the ash.

A second case, examined by Frerichs,[3] contained a little urea, leucin, tyrosin, and peculiar extractive substances.

Valentiner also found leucin and tyrosin in the urine of a woman with acute yellow atrophy; there was no urea, no lime, and no phosphoric acid.[4]

In a case of acute yellow atrophy, Scherer[5] found the urine icteric, without any trace of albumen or sugar; the urine contained uric acid, urea, earthy phosphates, a small amount of leucin, but no tyrosin; hippuric acid was not found.[6]

Schmeisser[7] examined the urine of a fatal case. The urine was clear yellow acid, and had a specific gravity of 1020. It contained no albumen, no sugar, no bile-pigments or bile-acids (?). A large quantity of tyrosin was discovered, but, apparently, no leucin. It is not stated whether there was any urea and uric acid.

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[1] Archiv des Vereins für wiss. Heilk., Band ii, p. 572; and Klinik der Leberkrankeiten, 1858, pp. 216 and 241.

[2] Frerichs thinks tyrosin to be a coupling of glycin and saligenin, just as hippuric acid is a coupling of glycin and benzoic acid. Thus—

$$\underset{\text{Glycin.}}{C_4H_5NO_4} + \underset{\text{Saligenin.}}{C_{14}H_8O_4} = \underset{\text{Tyrosin.}}{2HOC_{18}H_{11}NO_6}.$$

[3] Klinik der Leberkrankeiten, 1858, p. 220.

[4] Archiv des Vereins, Band ii, p. 572. Is not this case the same as that of Frerichs?

[5] Würzburg Verhandl., 1858, Band viii, p. 281.

[6] In this case the bile contained bile-acids; but no leucin or tyrosin. The spleen contained a little tyrosin, and no inosite, but leucin, hypoxanthin, and oxalate of lime. The liver contained hypoxanthin, and much tyrosin and leucin. The blood of the veins and right heart contained no tyrosin or hypoxanthin, but much leucin; that of the left heart showed no tyrosin, a little leucin and oxalate of lime.

[7] Archiv. der Pharm., 1859, quoted by Scherer, in Canstatt's Jahresb., Band ii, p. 79, 1860.

Sander[1] found, on the first examination of a case, bile-pigment, but no albumen; the urea and chlorine were lessened; there were casts and renal epithelium, tinged yellow. The next day, there was a little albumen and leucin, but no tyrosin. There were no bile-acids, though these were examined for by Hoppe's accurate method. Whether the absence of urea in the first case of Frerichs depended on mere retention, or partly on lessened formation, is not clear. Urea was in the blood, but of course the quantity present there could not be estimated. But, as Frerichs remarks, this was a case of retention to some extent, at any rate, without any albuminuria, though he appears (p. 241) disposed to think that the lessening in urea was caused by a want of complete metamorphosis of albuminous products. On this point nothing decided can at present be said.

Budd[2] has noticed a large amount of oxalate of lime, with casts and renal epithelium, in cases probably to be referred to this heading.

SECTION XIX.

ACUTE DISEASES OF THE JOINTS.

1. *Rheumatic Fever.*[3]

The urine of rheumatic fever presents the strongest type of febrile urine. It is scanty, of high specific gravity,[4] deeply pigmented, and deposits deep-coloured sediments of urates.

Normal constituents.

1. The water is, in the majority of cases, lessened. As in pneumonia, there is no diminution in the amount of water entering the system, but there is an increased exit by the skin, and the profuse sweats of rheumatism must have an effect on the urine. But that there is retention, also, is shown by the scanty urine of cases with dry skin.

2. The total solids are augmented,[5] chiefly from the increase in urea and pigment.

3. The urea is, in most cases, augmented, not apparently to such an extent as in pneumonia, but still very considerably.

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[1] Deutsche Klinik, 1860, No. 4.

[2] On Diseases of the Liver, 3d edit., p. 288.

[3] By this term I imply a severe febrile disease, attended with erratic non-purulent inflammation of the joints, without urate-of-soda deposits.

[4] Dr. Fuller, in his very useful work (On Rheumatism, 1st edit., p. 57), thinks that the high specific gravity is not owing to absolute increase in the solids, but merely to deficiency in the water; but the numerous analyses made since the work was published show the opinion is incorrect.

[5] See paper by Author on the Urine in Rheumatic Fever, Brit. and Foreign Med.-Chir. Review, Jan. 1854, p. 250.

Amount of urea in 24 hours.		Authority.
Grammes.	Grains.	
38·9	600	Wachsmuth: in a man aged 28.
39·0	602	Julius Vogel: mean of three cases in men, recorded by him.
40·7	629	Hegar: in a man.
56·5	872	Brattler: in a man aged 21; mean of 4 days (normal amount on 1 day subsequently in health, 27·41 grammes).

In three women, aged twenty-five, thirty-one, and fifty-two years, Brattler found in the height of the fever, 31·5, 25·05, and 21·75 grammes; in the two latter cases, the excretion was 11·55 and 15·07 grammes, in convalescence. I have also noticed in men and women an excess of one fourth or one fifth over the physiological amount.

These amounts are so large as to pass beyond the physiological range; and when, in addition, the very spare diet of rheumatic patients is considered, the great disintegration of nitrogenous tissue, represented by a daily excess of from 10 to 20 grammes of urea, is obvious. The weights are not given in any of these cases.

As in pneumonia, the amount of urea is greater in equal periods during the day than the night (Wachsmuth).

Brattler has attempted to connect the amount of urea with the temperature, but his observations are very loosely made. I quote them, however:

Urea in twenty-four hours.

Temperature, cent.	In 1 man.	Mean in 3 women.
	Grammes.	Grammes.
39° (102·2 Fah.)	40·1 (619 grains)	25·2 (389 grains)
38° (100·4 „)	58·8 (907 „)	22·2 (342 „)
37° (98·6 „)	32·4 (500 „)	14·5 (223 „)
36° (96·8 „)	27·4 (423 „)	...

4. The uric acid is simultaneously somewhat increased.[1] The mean in twenty-four hours, in two cases noted by me,[2] was 9·445

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[1] The somewhat doubtful observations of Picard, before referred to, would show that there is an increase in the urea in the blood in rheumatic fever. They are confirmed by a case of Neukomm's, in which the blood contained no less than 0·01 per cent. of urea.

[2] Brit. and Foreign Med.-Chir. Rev., Jan., 1854.

grains on the fourth, fifth, and sixth days in one case, and 12·694 grains from the fifth to the tenth day in a second case. In both instances, however, liquor potassæ was given, and some influence may perhaps be ascribed to it. The largest amount I have ever noted in rheumatic fever was 17 grains; the man was taking liquor potassæ, but when he was well, and took liquor potassæ as an experiment, the largest amount of uric acid passed was 9·8 grains; so that the former large quantity must be attributed to the disease.

There is usually a great precipitate of urates during the height of the disease, and at the commencement of improvement. Brattler states that the disposition for the urates to fall disappears at the period of improvement, but I think it is some days later.

4. The chlorides are often diminished, and sometimes disappear altogether. This diminution is not so great or so constant as in pneumonia: it is not necessarily associated with intense joint affection or effusion; in several of my cases when the chlorides were thus wanting, there was great sweating. I am not certain whether this was the case always, and certainly great sweating will occur in cases in which the chlorides are in some quantity; thus, one of my patients, who sweated most profusely, passed, on an average of three days, 5·18 grammes, or 80 grains, in each twenty-four hours. This case, however, was a sub-acute one, with slight joint affection; with no lessening of water, and with very slight fever.

In most cases I have found the chlorides, if small in amount, return soon after the joint affection has commenced to decline, or as soon as the temperature has fallen to 100° or 99° Fah. Howitz,[1] however, believes that the amount of chlorides is regulated entirely by the diet, and is unconnected with the movements of the disease. Brattler found the chlorides to be in inverse relation to the urea; they were always lessened; and this is ascribed by Brattler to the exudation. It is probable that three causes are in action,—deficient ingress in food, lessened egress in the urine caused by the disease, increased egress by other channels.

5. The amount of the sulphuric acid has been variously stated. In my observations I have found a very great increase,[2] the amount being sometimes double that passed during convalescence; in one case it reached 3·41 grammes, or 52·668 grains, in twenty-four hours, the normal amount at recovery being only 1·55 grammes, or 24 grains. This increase in the

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[1] Schmidt's Jahrb., 1857, No. 9, p. 283.

[2] British and For. Med.-Chir. Rev., Jan., 1854, p. 254.

sulphuric acid was constant in five cases;[1] in all of whom the fever was intense, and the joint affection severe.

In one case, indeed, termed rheumatic fever, there was no increase; the SO_3 amounted to only 21 grains in the twenty-four hours before treatment. But then this was an almost non-febrile case, though the pains were severe. The patient also was in a debilitated condition, and had lived badly. His urine in other respects also was not febrile; it was copious, pale, contained only 22·15 grammes, or 342 grains, of urea in each twenty-four hours (mean of five days), and was not deficient in chlorides.

Such almost a-febrile cases as these, occurring in debilitated subjects, should not perhaps be compared with the typical examples of rheumatic fever.

Some analyses, however, have been made in marked febrile cases in which there was no increase. Gruner[2] found it decreased in one case; it may be objected to this, however, that the analysis was made when the joint affection had almost disappeared, and when exudative pericarditis had commenced.

A less doubtful case is mentioned by Professor Vogel;[3] a girl, with "heavy rheumatic fever," passed "at the acme" 0·8 grammes, or 12 grains. But, as the age is not stated, we cannot be certain of the significance of this fact. It may also have been one of those cases in which, although there is really increased tissue change, there is retention of the products formed thereby.

In one case (before treatment) I determined the amount of non-oxidized sulphur in the urine.[4] It amounted to 5·519 grains in twenty-four hours, which is a little over the mean amount (4·125 grains) found by Ronald in his five healthy cases. It was unfortunately not determined on convalescence in my patient.

Although it is evident that many more cases are necessary to settle the point, it appears probable that the typical forms of rheumatic fever are attended with a greatly increased excretion of SO_3, and perhaps of sulphur-containing extractives, in consequence perhaps of the existence of highly sulphuretted compounds in the blood. I formerly thought that in no other febrile disease was there so great an excess of SO_3, as in acute rheumatism; but, since this opinion was published,[1] I have met with a case of pneumonia, in which an equally large quantity (59 grains) was passed as in any rheumatic case. It is interesting to remember that the composition of the blood in acute rheumatism and in acute pneumonia is somewhat similar; no other diseases have so great an excess of fibrine.[2]

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[1] In one case, however, liquor potassæ had been commenced, but the amount of SO_3 passed during the first day of treatment was no less than 70 grains (4·53 grammes), which is much too great a quantity to have been produced by the potash alone.

[2] Die Ausscheidung der Schwefelsäure durch den Harn., Inaug. Diss., Giessen, 1852.

[3] Neubauer's Anleitung, 2d edit., p. 265.

[4] This was done by first finding the amount of SO_3 in the usual way; another portion of urine was evaporated to dryness, cautiously incinerated with nitric acid, so as to convert all sulphur into SO_3, and the SO_3 was then determined. The difference between the two quantities gave, of course, the amount of SO_3 derived from direct oxidation of sulphur.

6. The phosphoric acid may be increased, as appears from the analyses of Hegar,[3] but the augmentation is trifling. Beneke[4] found the amount of earthy phosphates very variable; sometimes they were increased, sometimes diminished. My analyses show (the influence of food being taken into account) no diminution; perhaps even a slight increase. Brattler's experiments show great variation; often lessening. The change in the phosphoric acid, therefore, is not great.

7. The pigment and extractives are always greatly increased (Professor Vogel); the colour is extremely dark.

8. The bases have not yet been accurately determined.

9. The free acidity appears, to test-paper, to be very great. This arises in part, if not altogether, from the concentration; for Professor Vogel, in one case, found the free acidity to be greatly reduced.[5] This is a most interesting point, as much stress has been laid on the increase of the acidity in the urine, which (like the acidity of the skin and the fluids of the mouth) has been held to indicate an excess of acid in the system.

Abnormal constituents.

Lactic acid has been supposed, by several observers, to be present in rheumatic urine; but the readiness with which this acid forms after discharge renders all the experiments hitherto made doubtful. Acetic acid has been noticed by Fleury, and also, probably, formed after emission. Albumen appears in some cases; is generally in small amount, and is very transient. I have known it occur for a single day, and then disappear entirely. I found it temporarily in four out of nineteen cases, or in 21 per cent.; Becquerel, in seven of eighteen cases, or in 38·8 per cent. It is seldom attended by blood or by kidney structures. The very small quantity of albumen, and its very transitory appearance, constitute a remarkable difference between the urine of rheumatic fever and pneumonia. The kidneys, therefore, suffer much less frequently, and much less profoundly, in the former disease.[1]

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[1] British and Foreign Medico-Chir. Review, Jan., 1854.

[2] For an able discussion on this point, see Dr. Bond's paper on the Pathology of Rheumatism.

[3] Zur Wurdigung der Phosphorsaur. Erden, Archiv des Vereins, Band ii, p. 420.

[4] Zur phys. und path. des phosphor. und oxals. Kalkes. Gött., 1850, p. 24.

[5] Neubauer's Anleitung, 2d edit., p. 252; and Virchow's Handb., Band i, p. 476.

Incidental circumstances affecting the Urine in Rheumatic Fever.

Retention.—In a small number of cases, the excretion of urinary solids, instead of being copious, is deficient; the urea, uric acid, and sulphuric acid, are all in small amount. The causes of this are as obscure as in typhoid fever. There may be no disease of the kidneys, and no reason to suppose there is any impediment to the passage of urea and uric acid, if these substances were in a fit condition to pass off. I have as yet only observed constant deficiency of excretion in a single case. In other cases, there is, during an abundant excretion, a sudden and considerable decrease in the quantity both of solid and fluid passed, without any lessening of the general fever. In two cases in which I observed this, a local inflammation was simultaneously developed, viz., angina faucium, and pleurisy (probably) in the other. It may, of course, be a question whether the retention produced the local disease, or the local disease the retention; the former supposition seems most probable, because there is no reason to believe that idiopathic angina faucium produces lessened excretion, while we know that impure blood will excite local inflammations. The cause of the arrest of the excretion are as obscure as in those cases in which the amount is small throughout.

Action of other eliminating Organs.—The skin sometimes acts most profusely, both day and night; and it might be supposed that the quantity of urine would be lessened. Without denying that this may be the case, it is not invariable, or even, I believe, common. One of my patients sweated most profusely during the fifth, sixth, and seventh days of the joint-affection, yet his urine averaged 38 ounces in each twenty-four hours, which is more than is common. Another patient (with little fever, however) sweated continually, and yet his urine averaged 53 ounces in each twenty-four hours. It would seem, indeed, as if, instead of the skin and kidneys being antagonistic, as in health, the cause which made the skin act was also powerful in causing the kidneys to excrete water. In this case both the eliminating organs were acted on by some prior condition, which neutralized the influence which, under ordinary conditions, one would have exerted on the other. The sweating did not, either, reduce the total urinary solids, in one case in which I examined them during its height. As already said, I am uncertain of the influence of sweating on the chloride of sodium.

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[1] The disease called "nephitis rheumatica," by Rayer, and said to be characterised by special renal anatomical characters, is only congestion, with fibrinous deposits arising from blood-poisoning.

Dr. Laycock has described (Edinburgh Medical Journal, August, 1857), in the urine of rheumatism or gout, or of persons "diathetically rheumatic or arthritic," certain microscopic elements, viz.: 1. Nucleated cells resembling the epithelium cells of the convoluted tubuli uriniferi. 2. Rounded masses of granules or nuclei. 3. Free nuclei. These several bodies float together, and constitute the "granular small curd-like masses which float here and there in the mucous cloud;" they are considered by Dr. Laycock to be "the epithelium cells and nuclei of the convoluted tubuli uriniferi, intermingled with similar products from the calyces pelvis and ureters," and are considered to be especially indicative of the rheumatic condition. I content myself with quoting Dr. Laycock's statement. I differ with hesitation from so good an observer; and desquamation from the urinary tubules may be more common than I have found it to be in rheumatism; but I cannot but think Dr. Laycock has overrated the frequency of its occurrence.

Free and even sometimes slight purging, as by colchicum, reduces the amount both of water and of solids. The effect of the intestinal excretion is, as far as the quantity of urine is concerned, more marked than that of the skin.

Medicines.—Very few accurate observations on the influence of medicine have yet been made.

The carbonated alkalies, as well as the tartrates, citrates, acetates, &c., render the urine alkaline; whether they do so more or less easily in health, is not known. They render the colour paler, increase the water, and augment the solids, on account of the quantity of the carbonate which passes off; deposits of lithates often disappear. The exact effect on the urea, uric and sulphuric acids, in acute rheumatism, has not yet been determined.

Liquor potassæ, in large doses,[1] increases slightly the quantity of water, renders the colour pale, and augments the organic solids and the sulphuric acid. It probably augments also, in some cases, the phosphoric and, perhaps, the uric acid.

Nitrate of potash.—The nitrate of potash has been long employed in rheumatism, and has, lately, been particularly recommended by Drs. Basham and Charlton. I have only had the opportunity of determining its action in one sub-acute case on the SO_3. For five days (during which 4 drachms of colchicum wine were taken), the average excretion of SO_3 was 32·29 grains in each twenty-four hours; during six following days, 2 ounces and 4 drachms of nitrate of potash being taken, the daily excretion was 46·816 grains; while, on four following days, when no medicine was taken, the daily excretion sank to 32·436 grains, or almost precisely the same as before the nitrate of potash. The nitrate of potash was pure, contained no sulphates, and there did not appear to be any circumstance which could interfere with the certainty of the result. The effect on the other ingredient was not determined; but this observation agrees with the result obtained in my experiments on the healthy subject. It may, therefore, be concluded that nitrate of potash aids the elimination of sulphuric acid.

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[1] Observations by the Author, British and Foreign Medico-Chirurgical Review, January, 1854, p. 248.

2. *Acute Gout.*[1]

The urine has been examined between, during, and after the paroxysms of acute gout.

A. *Between the paroxysms.*

The urine of a patient was examined for ten days before an attack of gout, by Dr. Böcker.[2] It was found to be very deficient in solids, especially in urea, uric acid, extractives, and phosphate of lime; the phosphate of magnesia was less affected.

Previous to this observation, Dr. Garrod had observed the same fact with reference to the uric acid, which, immediately before the gouty paroxysm, was diminished or absent;[3] and Lehmann[4] has confirmed this remark, in cases of chronic gout with tophaceous deposit.

Dr. Ranke has informed me that, in two cases with tophaceous deposit, the urine contained no uric acid when acute attacks were absent.[5]

B. *During the paroxysm.*

1. The water.—The amount seems to vary greatly; occasionally it is scanty, and the urine takes on the marked febrile type; but, especially in patients in whom there have been repeated attacks, the urine is often as copious as in health. The mean amount of water in the acute cases recorded in Dr.

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[1] I define gout, after Garrod, as a febrile affection, with inflammation about joints, leading to a deposit of urate of soda.

[2] Zur pathol. der Gicht. Rhein. Monatsch., Feb., 1850; and Canstatt's Jahresb., Eisenmann's Report on Chronic Diseases for 1850, p. 158.

[3] Med.-Chir. Trans., 1848, vol. xxx.

[4] Lehrbuch der Phys. Chem., vol. ii.

[5] Occasionally, however, without any gout, no uric acid can be found in the urine; so that, unless the observations are continued over several days, it is hazardous to draw a conclusion.

Garrod's work[1] (omitting two cases, with a single day's urine only) is 41, 51, 35, 24, and 36 fluid ounces—an amount which, on the whole, is a little below the healthy mean. But there is great variation in this respect.

2. The urea.—Few analyses have yet been made. In a man, aged fifty-seven, Garrod found the mean amount to be 320 grains, which, considering the man's age and diet, is, probably, not below or above the standard.

The following analyses in one of my cases gives the urea and some other ingredients. The man was forty-nine years of age, small, and emaciated; the feet, ankles, knees, and hands were all affected; he had been subject to gout for many years.

Temperature.	Water.	Urea.		Sulphuric acid.		Phosphoric acid.	
	c.c.	Grammes.	Grains.	Grammes.	Grains.	Grammes.	Grains.
100° Fah.	720	20·88	322·3	1·6	24·75	0·61	9·5

The chlorine must have been in small amount, as the soluble salts amounted altogether only to 4·24 grammes (65½ grains). There was a large deposit of pale urates, and a drop of acid precipitated at once a dense cloud of uric acid and urates.

The total amount of solids was 26·38 grammes (407·37 grains); and as the urea and the soluble salts made up 25·12 grammes, it only leaves the small amount of 1·26 grammes (19½ grains) for the uric acid and pigment.

Now here it was clear that the urea was in tolerable though not in great amount; and it corroborates Garrod's assertion that the elimination of urea is not interfered with, during the paroxysm. Nor is there any evidence that it is increased. At the same time, it must be remembered how few cases have been examined.

3. The uric acid.—Dr. Garrod has shown that the elimination of uric acid is lessened in the paroxysm of gout; the means of his analyses in seven acute cases were 5·95, 2·05, 2·58, 3·76, 4·46, 3·28, and 3·28 grains, and the mean of the whole number is 3·62 grains (healthy mean, 8·569 grains). As the smallest mean amount yet noted is higher than this, there can be little doubt of the correctness of this statement.

As the uric acid exists in such large quantities in the blood, it is to be presumed that its formation is not impeded, but only its elimination.

The relative proportions of the urea and uric acid have been a good deal discussed; and Dr. Gairdner, in his interesting work,[1] has thrown out the suggestion that there is a mal-direction of metamorphosis, and that the substances, which would in a healthy state become urea, in gout are converted into uric acid. But the analyses on which this is based are not yet numerous enough to allow us to consider this suggestion as more than a hint for future inquiry.

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[1] On Gout, 1859, p. 158.

What is the cause of the non-elimination of uric acid? No answer can be given to this; but we shall presently see that there is also retention of other ingredients.

4. Nothing is known of the hippuric acid.

5. The pigment varies. Sometimes, in very febrile gout, the urine is deep red, and like the urine of acute rheumatism; but in other cases, the urine is very pale, and the pigment is evidently deficient. My case already quoted is an example of this; it is a most remarkable instance of an almost total absence of pigment and extractives, without deficiency of urea. I examined also, in this case, if there was any unoxidized sulphur in the urine, but there was no trace.

In another case, there was 1·796 grains of unoxidized sulphur—an amount which, as far as the few analyses yet made will allow a conclusion, appears to be below the limits of health.

6. The phosphoric acid was greatly lessened in my case, as in Böcker's; and as phosphate of lime is found in the tophaceous deposits with urate of soda, it is very possible that the retention of this product, as of the uric acid, will be found to be common.

7. The chlorine has not been carefully determined in any case.

8. The SO_3, in my case, was quite in its normal amount; so that it is to be presumed that, as in the case of the urea, there is no retention and no want of metamorphosis of the sulphur-holding tissues.

9. The free acidity has been said to be both lessened and increased in gout, but no accurate examinations appear to have been made. In my case before referred to, the free acidity was equal in twenty-four hours to 28 grains of crystallized oxalic acid. As the SO_3 was not in large amount, and the phosphoric acid was very small, it must be supposed that some other acid (organic? lactic, acetic, formic?) was in the urine.

Abnormal constituents.

Albumen is not at all uncommon in small quantities; it is generally temporary. When it is persistent, there is reason to suspect the chronic disease of the kidney, produced by gout (Todd). Casts of tubes are sometimes seen. Oxalate-of-lime crystals are very common.

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[1] On Gout, by William Gairdner, M.D.

The amount of oxalic acid has not been determined: no conclusion, at present, can be drawn from the presence of the crystals in the urine. When degenerative changes are going on in the kidney, we have the usual microscopic evidence of casts and epithelium.[1]

Uroxanthin is very common, and blue pigment is sometimes seen. Gout often gives us another instance of the rule, that deficient normal pigment occurs with an increased amount of uroxanthin.

In one case I obtained a very large quantity of indigo, by simply adding a little hydrochloric acid. I have never seen this in acute rheumatism.

3. *After the paroxysm.*

The water is usually copious. The amount of urea and pigment has not been determined. The uric acid is, according to Garrod (p. 166), often much increased when the fit is passing off, and just after the paroxysm. Whether the phosphoric acid is increased, is not yet known.

The albumen, if it has been present, usually disappears.

In sub-acute and chronic gout, deficiency of uric acid appears, from Garrod's cases, to be still more marked. Sometimes none could be found, and sometimes it was excreted in some quantity. The excretion is, so to speak, intermittent.

A little albumen is very common (Garrod).

Incidental circumstances affecting the Urine in Gout.

I am unacquainted with any circumstances showing the influence of diet, or alterations in the other eliminating organs.

Effect of Remedies.

Dr. Garrod has proved conclusively, that colchicum does not increase the amount of uric acid. For the evidence on this point, his work must be referred to.

In the case formerly described, I gave bicarbonate of potash, and add the results as a contribution towards future inquiry.

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[1] The reviewer of Dr. Garrod's book, in the Brit. and For. Med.-Chir. Rev., April, 1860, p. 43, states that he has repeatedly found casts *without albumen*. In other diseases this has been also observed.

CASE I.

Date.	Medicine.	Urine of 24 hours.							
		Quantity.	Specific gravity.	Solids.	Urea.	SO_3.	PO_5.	Acidity = oxalic acid	Unoxidized sulphur.
		c.c.		Grains.	Grains.	Grains.	Grains.	Grains.	
Jan. 2	None . .	720	1024	407·87 [1]	322·39	24·756	9·445	28	. .
„ 3	Bicarb. pot. ℈viii in the first 12 hours	1050	1027	625·38 [2]	454·05	28·691	27·534	Alkaline .	3·758
„ 4	None . .	825	1026	. .	356·75	23·478	13·666	46·330	. .
„ 5	Bicarb. pot. ℈viii in the first 12 hours	1360	1020	. .	357·06	25·243	21·88	Alkaline in 24 hours; became slightly acid . .	. .
„ 6	None . .	1650	1017	. .	356·75	25·86	14·008	42·924	. .

On the 5th, the joint-symptoms were well.

The bicarbonate of potash was given in the first twelve hours of the day, so that, if possible, its effects might not extend into the following day's urine. It appeared on the first day to increase the urea considerably, the sulphuric acid in a less degree, and the phosphoric acid in an extraordinary degree. When it was afterwards given, the effect on the urea and sulphuric acid was very trifling; but the phosphoric acid, which had fallen, was again increased, and fell again the next day. The effect on the acidity of the urine was very interesting; although it produced alkaline urine for the time, yet on the following day the acidity was raised to almost double the amount it had been before the medicine was taken. On the day when the second quantity of alkali was taken, the urine was again alkaline; but, on the following day, the acidity was again very greatly increased. In fact, the acidity of the fourth and sixth days, when no medicine was taken, is so great as to give an average of acidity equal to 22·3 grains of oxalic acid for the four days, although, on two of the days, a large quantity of alkali permitted no acidity to be perceived. It is evident, therefore, that the alkali increased, in reality, very largely the excretion of acid.

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[1] The solids contained 65·52 grains of soluble salts.

[2] The solids contained 187 grains of soluble salts.

CASE II.

Calculated Urine of twenty-four hours.

	Quantity.	Solids.	Sol. salts.	SO_3.	Unoxidized sulphur.
In 11 hours, no medicine being taken: calculated for 24 hours	Ounces. 23½	Grains. 363·171	Grains. 54·36	Grains. 21·46	Grains. 1·796
In 13 hours, ʒiv of bicarb. of potash being taken: calculated for 24 hours	74	847·12	273·4	27·5	7·002

In the former case, probably about two thirds only of the bicarbonate passed off in the twenty-four hours; but in this nearly the whole of it must have been eliminated in the thirteen hours during which it was taken. It increased the organic solids, the SO_3, and the substance containing unoxidized sulphur. The effect on the PO_5 was not determined.

To sum up our knowledge of the urine in gout, it may be said that, before the paroxysms, there is diminution of all the chief ingredients, especially of the uric acid, phosphates, and pigment and extractives; that during the paroxysm, there is also insufficient elimination of uric and phosphoric acids, and extractives, but that the urea and sulphuric acid are in good, though not in excessive, quantity; that, after the paroxysm, the elimination of the uric and phosphoric acids increases. As there is reason to think there is no deficient but rather an increased formation of uric acid in the blood, the want of excretion must be owing either to some affection of the kidney (which is unlikely), or to some peculiar and unnatural combination in the blood or organs, which hold back this and other substances. If this be the case, the deficient elimination is, as it were, only a consequence of more important antecedent aberrations in metamorphosis, of which impeded excretion is a natural sequence. What these are, however, is quite unknown; but an unnatural formation of uric acid, either from food or tissues, may possibly be part of them.

SECTION XX.

ACUTE DISEASES OF THE SKIN.

Acute Ecyema Impetiginodes.

In a man aged twenty-one, weighing 55 kilogrammes, whose body was almost entirely covered with the eruption, Dr. Beneke[1] made the following interesting observations:

On a mean of twenty-six days, the solid and fluid ingesta in each twenty-four hours amounted to . . . . . . 3660 grammes.
The egesta each in 24 hours amounted to—
Kidney excretion . . 2023 grammes
Intestine „ . . 121 „
Skin and lungs „ . . 1495 „
} 3639[2] „

The body, therefore, increased in weight.

With respect to the urine, the following table gives the mean of three periods.

In each twenty-four hours, there was excreted by the kidneys, in grammes—

	No. 1. No medicine. Mean of 4 days. Disease increasing.	No. 2. Liq. pot. ℥ix in 10 days. Mean of 10 days. Disease increasing at first, then declining.	No. 3. After liq. pot. No medicine. Mean of 12 days. Disease declining.
Quantity	1779	1826	2216
Specific gravity	1014·3	1013·7	1011
Acidity taken as oxalic acid ...	1·87	1·79	...
Urea	36·3	29·93	28·842
Uric acid	0·484	0·349	0·380
SO_3	1·855	2·181	1·950
PO_5	2·452	2·767	3·884
Chloride of sodium	11·19	9·564	11·594

In the first three days, there were numerous crystals of oxalic acid in the urine.

One kilogramme of body-weight excreted in twenty-four hours 0·654 of urea during the height of the disease, and 0·524 during the decline.

The urea was therefore in some excess during the period of severe disease; the uric acid was also a little over the amount of convalescence; the sulphuric acid was not augmented by the disease, though it was so by the potash. The phosphoric acid was a little increased during the use of the potash; but as it was in still greater quantity afterwards, it may have been merely rising in amount as the disease went off. During the acute stage, it was evidently diminished (retained ?). The free acidity was at first a little below the rule, and was scarcely altered by the liquor potassæ.

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[1] Archiv des Vereins, Band ii, p. 35.

[2] These numbers are to each other, if the urine be taken as unity, as 1, 0·059, 0·73.

Grosse gives the numbers in health as 1, 0·09, 0·7. Beitrage zur Kenntniss der Grosse des menschlich Stoffwechsels. See Introduction, p. 33.

The decrease in the urea and the uric acid must be ascribed to the gradual improvement in the disease, and not of course to the influence of the liquor potassæ.

Acute Urticaria.

Dr. D. Maclagan,[1] in examining the urine in a case of acute urticaria, believed the urea and uric acid to be in very small amount; but the per-centage amounts only were determined, and the urine may have been merely dilute. No such deficiency has been noticed in other cases.

SECTION XXI.

GENERAL CONCLUSIONS ON THE CONDITION OF THE URINE IN FEBRILE DISEASES.

The urine in almost all febrile diseases has certain characters, sufficiently common and constant to have at all times attracted attention. These are a deficiency of water, a deepening of colour which arises from absolute increase of pigment, as well as from concentration, and a heightened relative acidity produced only by the deficiency of water (Vogel). These characters are not, however, peculiar to fever; for they will occur in certain chronic apyrectic affections, especially of the liver.

In addition to these obvious and well-known characters, the so-called "febrile urine" presents other more recondite but not less important phenomena. If no incidental circumstances come into play, the urine gives evidence in most cases of a remarkable increase of the urea and the uric acid, the representatives of the nitrogenous tissues. As very little food is taken, and as the amount of these substances is often much more than in health, the inference is unavoidable, that the patient is, so to speak, feeding on his own nitrogenous tissues, which rapidly waste and disappear. So far the urine resembles that which is produced by excessive flesh-feeding; but, in addition, hippuric acid would appear to be present in many cases in large quantities—a peculiarity of metamorphosis which finds no parallel when the urea and uric acid are heightened artificially by increase of nitrogenous food. As already said, the pigment, derived, it is supposed, from metamorphosis of the red blood-cells, is also increased; and so is the SO_3, the amount of which is, to a certain extent, an indication of the metamorphosis of the sulphur-holding (*i. e.* nitrogenous) tissues.

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[1] Monthly Journal of Med. Science, August, 1846, p. 157.

The chlorides and the phosphates, on the other hand, are, except in exceptional cases, not increased, or are decreased. Allowing full weight to the deprivation of food, and to the increased action of the skin or bowels, I think we are justified in saying that, as a rule, there is retention of chlorine,[1] and deficient metamorphosis of the structures furnishing phosphoric acid, except possibly in the acute inflammations of nervous and muscular tissues.

This increased excretion certainly commences very early in febrile diseases, and it is probable, from the experiments in ague, that it begins at the very onset, and is, with the alteration of temperature, one of the earliest, perhaps the earliest sign of the morbid condition; throughout it runs more or less parallel with the heightened temperature, and, with occasional exceptions and deviations, which are generally easily accounted for, it may be laid down as a rule, that the presence of the one condition implies that of the other.

Yet this is not the case always; for (apart from incidental circumstances) in some fevers there is occasionally, first, a very high temperature with no great amount of metamorphosis, and second, there are chronic diseases without increase, or even with decrease, of temperature, in which there is augmented urinary elimination. In the first case, the exception is accounted for sometimes by the fever being of short duration, being followed by a pyrectic period, in which metamorphosis is below the normal, so that if the pyrectic and apyrectic periods are put together, the deficiency in the one more than counterbalances the excess in the other. Or the excretion of the urine is, as it were, supplemented or compensated by the augmented action of other organs, especially of the skin or bowels; or is diminished by previous inanition, and by the want of material from which urea and uric acid can be derived. In the latter case (of an a-febrile disease, and increased urinary elimination) it is possible that there may have been, in some cases, a previous retention followed by increased elimination; but it would be hazardous at present to affirm that this will explain all cases.[2]

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[1] I believe this was pointed out first by Schonlein, but I have not been able to find the reference. I had observed the fact, without knowing this.

[2] The cause of the increased elimination in febrile disease is extremely obscure. It can scarcely be considered as arising altogether or simply from the increased

When the amounts of different normal constituents of febrile urine are considered, we are struck at once by the disproportionate augmentation of the uric acid; it varies indeed in different diseases, and in different cases, but as a general rule it is more constantly augmented than any other constituent. Why, if there be augmented oxidation in the febrile system, should the uric acid not be converted into urea and carbonic acid, as it undoubtedly is when it is introduced into the healthy system? As has been already remarked, in fevers the amounts of the urea and of the uric acid seem quite independent; they vary from day to day, without connection, or one remains stationary while the other increases; not the slightest idea of mutual dependence is given when the table of a disease, with the quantities of uric acid and urea marked on it day by day, is looked at. We should certainly say that they arose from the metamorphosis of different tissues, if there did not always arise the recollection of the undoubted fact of the production of urea from uric acid introduced into the body. Perhaps, however, uric acid arising in the process of normal or abnormal metamorphosis may be in a special condition, or may be protected by some form of combination which cannot be assumed when uric acid is introduced into the body. In connection with the increase of uric acid, it is not impossible not to connect again this symptom with the congested spleen so common in all pyrexial diseases.

The production of hippuric acid is a subject of great interest; it may indicate a mal-action of the liver; for it must be supposed that glycin is either produced in excess, or that the elements which should form it do not do so in consequence of the

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rapidity of circulation. The most recent hypothesis is, that there is a loss of the controlling power of the nervous system over nutrition (over the contractility of the vessels?), which renders the nitrogenous tissues more liable to the aggressive influence of the continually inspired oxygen; and this idea is, to a certain extent, supported by experiments. Another conjecture may be, however, that the tissues in pyrexia lose the protection which the presence of some substance, present in health but not in fevers, gives them. Liebig, with that suggestive genius which renders his writings so attractive and so useful, indicated years ago that "starch, sugar, and fat serve to protect the nitrogenous tissues" (Letters on Chemistry, 3d edition, p. 374). And this hypothesis—for at the time it was scarcely more—has since been, in its essence at least, confirmed by the exact researches which have been detailed in former pages. We have seen how vast an arrest of nitrogenous metamorphosis is apparently produced by the use of sugar (see page 61, for Böcker's experiments); supposing that the secretion of sugar is arrested in the body, and its protective influence therefore withdrawn, should we not have an augmented metamorphosis of the nitrogenous tissues? And, singularly enough, it has been shown by Bernard that dogs, when febrile from wounds, cease to form hepatic sugar. This hypothesis, however, may seem to be contradicted by the fact that in diabetes, with enormous formation of sugar, the nitrogenous metamorphosis is often active; but in this case, from some cause or other, the sugar cannot be destroyed, so that the oxygen is not appropriated by it. It is, therefore, really no argument against this view.

stronger attraction of some body which acts upon them, as benzoic acid will do when it is taken into the system. Or is it possible to suppose that there is in pyrexia an increased production both of benzoic acid and of glycin?

The retention of the water and of the chloride of sodium are facts of which no explanation can yet be given. And at present we cannot do more than surmise, that it is by some condition of the skin that the usual rule in the pyrexia, as respects these ingredients, is so remarkably violated in the case of ague.

As the general febrile state is common to all the diseases considered in the preceding section, so the condition of the urine which is so closely connected with augmented temperature is found in all. There are, however, some specific differences; and it is probable that, as inquiry advances, our knowledge of these differences will become much more precise than it now is.

These differences may arise—

1. From the locality of the disease. Whenever an organ is affected, the metamorphosis of which furnishes any special products, such products may be found in excess in the urine. Thus, the phosphates increase in inflammations of the nervous tissue; the bile acids in some cases of hepatitis; and, in all probability, the uric acid in splenic engorgement; the chlorides are especially lessened in pneumonic exudation, as they are poured out with the albuminous mass into the lung; in milk fever, sugar is found in the urine, &c.

2. From the presence of abnormal substances peculiar to the disease. At present it can scarcely be considered that we have sufficient proof of this cause. Perhaps some compound rich in sulphur may be present in rheumatism; and perhaps organic acids, unusual in the healthy urine (valerianic, formic?), will hereafter be found there.

3. From a perversion of metamorphosis special to a disease. On this head we at present know scarcely anything. The existence of leucin, tyrosin, and peculiar extractives, in the urine of the acute yellow atrophy of the liver, is perhaps owing to the peculiar change in that organ.

4. From the course of the disease, and especially from the variable action of the other eliminating organs. For example, the presence of diarrhœa in typhoid fever modifies the excretion of the urine. So also in acute gout, there are peculiarities of renal excretion which sometimes distinguish the urine of that disease from that of all others.

5. From impediment to excretion from kidney implication, or without it (gout?). Kidney implication is not special to any disease, and may be absent in all; but it occurs more frequently

in some; and sufficiently so, in fact, as almost to make specific differences.

None, however, of these differences are so great, or so constant, as to aid us in differential *diagnosis*. The general febrile characters, so to speak, override the others; and, at present, from the urine alone, we cannot tell whether the case be one of typhoid fever, smallpox, rheumatism, or pneumonia. The great uses of the examination of the urine are for *prognosis* and *treatment*. The amount of metamorphosis is a good indication of the severity of the disease, and may indicate the necessity of restraining it; or if exudations are to be got rid off, a copious excretion may show us that the chemical alterations ending in elimination are proceeding satisfactorily without aid. On the other hand, we may detect, by the urine, insufficient elimination in a disease in which the thermometer indicates a great metamorphosis, and measures may have to be taken to augment such elimination. The perusal of the first two chapters will show how this is to be done, as far as our present knowledge of articles of diet or of medical agents extends.

The urine has been seldom examined *before* an attack of pyrexia, except in gout and ague, neither of which diseases can fairly be taken to represent the probable course in other affections; because, in reality, between the fits of ague or gout, there is no complete absence of the disease, but merely another form of it.

It would, however, be extremely important to know if in other diseases, prior to the actual commencement of augmented temperature, there is deficient urinary elimination.

After an attack of pyrexia, as already said, the urine takes on characters entirely the reverse of those in the febrile period. The chloride of sodium and the water are augmented; the urea, uric acid, and pigment are below even the average of health. There is, indeed, a delayed metamorphosis, which is evidenced not only in this way, but also, probably, by the presence of oxalic acid in increased quantity; at any rate, oxalate-of-lime crystals have been shown by Walshe to be more frequent in convalescence than at other times.

SECTION XXII.

ACUTE NON-FEBRILE DISEASE.

Only one disease belongs to this class, viz., *cholera Asiatica*, the temperature in which falls three, four, five, or even six degrees below normal blood-heat.

During the algide stage, there is suppression of urine, apparently from lessened circulation, thickened blood, and exudation into the renal tubules. Occasionally, patients state that they have passed urine after the occurrence of vomiting, purging, and cramps, and even during the whole period of the cold stage. Satisfactory evidence on this point has, however, not been given. After the cold stage is over, urine is passed or, as in a certain number of cases, is suppressed, and the patients die comatose.[1]

When the secretion of urine returns, it is between the 18th and 144th hours; most usually between the 48th and 72d hour after the commencement of the attack. In 133 cases, noted by Buhl, the per-centage was as follows:

9·9	per cent.	between the	18—24	hours
26·6	„	„	24—48	„
30·4	„	„	48—72	„
19·4	„	„	72—96	„
11·0	„	„	96—120	„
3·2	„	„	120—124	„

Normal Constituents.

1. The water.—The quantity of the first urine is usually small; it then gradually increases, in cases of recovery, and on the third—sixth day (Buhl) reaches its maximum, being then often much more copious than in health. In cases fatal from sopor, it generally continues very small in amount.

The specific gravity of the first urine varies from 1006 to 1020 in the first urine; it often falls as the water increases in amount, and rises again when the urine becomes normal.

2. The urea is in very small amount, in the urine passed in the first twenty-four hours; it then, like the water, gradually increases, and about the third—sixth day is much above normal. Buhl has found it amount even to 70 or 80 grammes in twenty-four hours at this time, whereas on the first day it may not exceed 3 to 6 grammes, or even be absent (Begbie). Brattler noticed as much as 57 grammes, on the day when the albumen was disappearing, while in perfect convalescence there were only 36 grammes. After reaching this amount, it gradually falls to the normal excretion. The prognosis is favorable in proportion to the excretion

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[1] A great number of observations have been made on the urine of cholera. The best description is that given lately by Buhl (Henle's and Pfeuffer's Zeitsch. für rat. Med., 1855, Band vi, Heft i). Almost all preceding observations are confirmed by Buhl, and therefore I have chiefly followed his description.

of urea; there are, however, exceptions, for cases sometimes die with a considerable amount of elimination.

3. The uric acid is usually present in the first urine, but its quantity is unknown; it is often precipitated on account of the presence of free acid; and sometimes, as there is little normal pigment in the urine, it falls almost colourless.

4. Hippuric acid is often present, but its amount is not known.

5. The phosphoric acid is first in very small amount; then gradually increases, and, like the urea and water, surpasses the normal amount; its range is from 0·189 to 2·208 grammes in the first twenty-four hours, to 6 to 9 grammes on the third—sixth day.

6. The sulphuric acid appears to vary: it has been found increased, by Vogel; decreased, by Letheby. I believe the latter is generally the case at first.

7. The chloride of sodium is, at first, almost absent; it then, after the fifth day (eighth, Güterbock), gradually returns; and, according to Buhl, its increasing amount is of more favorable prognosis even than that of the urea. Its maximum of elimination (which is, however, never great) is a day or two after that of the urea; the urea, in fact, is often beginning to fall when the chloride of sodium is increasing.

8. The earthy salts are also deficient in the first urine, and then gradually return.

9. The free acidity of the cholera urine is considerable. Buhl states the first urine is sometimes neutral, and that the acidity increases in the urine subsequently passed. I have generally noticed, however, that even the first urine was tolerably acid, though the acidity is certainly greater afterwards. The cause of the acidity is unknown (lactic acid?).

10. The normal pigment is deficient for two or three days, and then gradually returns. The urine has a smoky, brownish tint, from hæmatin; or sometimes it has a perfectly clear, transparent yellow colour, from abnormal pigment, which is the uroxanthin of Heller (indican).

Abnormal Constituents.

Albumen is present in the first urine passed in the vast majority of cases,[1] and lasts from one to four days, gradually decreasing in amount; it has, in fact, a course almost inversely that of the urea. Buhl and Pfeuffer believe albumen to be very seldom, if ever, absent, if the first urine be examined.

It has, however, been noted as absent in some cases; in one out of forty cases examined by Busk;[1] in fourteen out of sixty-seven, by Begbie;[2] in four out of twenty, by Frua;[3] and in some of Dundas Thomson's cases. Becquerel states that it is generally absent, but this is an entire mistake. In none of my cases (about twelve, in which the first urine was examined) has it ever been absent; but I have twice seen it in small amount. The presence of albumen has been suggested, by Buhl, as a diagnostic mark between true cholera and severe diarrhœa occurring in cholera epidemics. As remarked, however, by this writer, albumen may occur in the urine of simple diarrhœa;[4] so that this distinction will not always hold good. The amount of albumen has a general, though not very close, relation to the severity of the algide stage. I have, however, seen it large in slight cases, and the reverse.

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[1] This fact was first noticed by Hermann, in Moscow, in 1830.

Sugar is occasionally present,[5] sometimes in large quantities, in the first and second day's urine.

Pigment.—A substance which gives a beautiful violet-purple, and sometimes transient reaction with acids, is present with the first urine in all cases.[6] It has never yet been noted as absent in any instance in which it has been looked for. It is soluble in alcohol. The reaction with acids is much the same as that given by Heller's uroxanthin; whether it is this substance, or some modification of bile-pigment, is not yet known.[7] If albumen be present, and be thrown down by nitric acid, it is coloured violet, purple, or dark brown, by this substance. It soon disappears, even before the albumen. It is, in my opinion, the best diagnostic mark of cases in which the symptoms are so slight as to make us uncertain whether we have to deal with cholera or not.

Sometimes this pigment takes on a blue colour, when a drop or two of nitric acid is added in the cold, and the mixture allowed to stand. Black-coloured urine has also been noted, but it may have been owing merely to dissolved hæmatin.

Dissolved blood colouring-matter is not unfrequently seen; the exact frequency of its occurrence is uncertain. A sulphureted compound (probably sulphuret of ammonium) is sometimes present. It is not common: I have found it in two or three cases, in perhaps twenty.

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[1] Quoted by Gull, in Report on Cholera, College of Phys., 1854, p. 136.

[2] Monthly Journal, Oct., 1849.

[3] Canstatt's Jahresb. for 1856; Eisenmann's Report, Band iv, p. 163.

[4] Finger found it in 8 of 65 cases of customary diarrhœa.

[5] Heintz, Samoje, Buhl, loc. cit., p. 25.

[6] See Begbie's interesting paper, in the Edin. Med. Journal, 1849, and paper by Author in the same journal.

[7] A precisely similar reaction can be sometimes obtained from the thin fluid of the cholera dejections. The substance certainly resembles that described in the section on "Blue Pigment." Zimmermann has found a substance assuming a blue colour in the blood of cholera, and believes it to be a modification of hæmatin.

Morphological elements are seen in every case of cholera urine; viz., casts of tubes, often beautifully perfect and transparent, renal epithelium, and, to an immense extent, bladder-epithelium. Renal and bladder catarrh are invariable sequences of cholera; and, in twenty-four to thirty-six hours after the first urine is passed, perfect pus-cells and ill-formed epithelium are also found in great numbers. Blood-corpuscles are often present at first, and crystals of uric acid. At a later date, urates and oxalate-of-lime octahedra generally make their appearance.

The casts and blood-corpuscles disappear long before the albumen; according to Frerichs, the abundance of casts is favorable, as showing that the conduits of the kidneys are being freed from the exudation which had occurred in them in the cold stage.

At present, the researches on the urine in cholera do not throw any light on the remarkable alterations in circulation and diffusion which occur in that disease. There is, evidently, at first, retention of all urinary products; and then, when the circulation is restored, and the kidney-tubes are cleared of their albuminous plugs, there is compensatory elimination. But is there any lessened, heightened, or perverted metamorphose during the algide stage, or afterwards? Only one case is known to me in which the examination of the urine was carried on for a long enough time to give any kind of answer to this question. It is the first case recorded by Buhl.[1] A man, aged thirty-three, began to pass urine on the fourth day. From this time to the end of the twelfth day, he passed 404·434 grammes of urea, 25·609 grammes of phosphoric acid, and 30·255 grammes of chloride of sodium. His excretion during these nine days was, therefore, as far as the urea is concerned, over the average; a little below the average for the phosphoric acid, and much below it for the chloride of sodium. If, however, we take the whole twelve days of the disease (during the first three days of which no urine was passed), and assume that urine was passed as usual on each day, we have a daily excretion of—

33·703 grammes of urea.
2·136 „ phosphoric acid.
2·521 „ chloride of sodium.

That is to say, if the kidneys had acted daily he would have passed about a normal amount of urea on each day, and the excess in the latter period may have been owing simply to the non-excretion of the first three days; there is, therefore, so far, no evidence of either augmented or depressed metamorphosis, but merely of retention and subsequent elimination. The phosphoric acid was below the mean, and perhaps there may have been loss of this acid in the stools. The chloride of sodium was greatly less than normal, owing, no doubt, to the previous loss with the stools; so that almost all that was taken as food, during convalescence, was held back by the body, which had been drained of its salt.

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[1] Three other cases recorded by Buhl cannot be used; for in two a day is missed out, so that the excretion is not known for those days; and in the third some urine was lost on one day.

It will, however, be imprudent to draw general conclusions from a single case.

That there is perverted metamorphosis in cholera is shown, at present, merely by the peculiar pigment; for the albuminous and the exudation casts, &c., are merely evidences of great kidney congestion and exudation. The import of the pigment is not known; but it is not peculiar to cholera.

CHAPTER IV.

CHRONIC DISEASES (NOT RENAL).

Chronic diseases may be separated into two great classes, those which are, and are not, febrile. In some cases, however, the line of demarcation between the two series is not marked, or one class may temporarily pass into the other.

The chronic febrile diseases are often later stages of the acute; and the urine, as far as it has been examined, resembles that of the disease they follow. As the observations of the urine in this class are, however, fragmentary and imperfect, it is inadvisable to occupy space by a detail of the appearances in chronic febrile bronchitis, pneumonia, peritonitis, or rheumatism, or gout.

The chronic a-febrile diseases constitute a vast class of maladies, which are notoriously intractable and persistent. The condition of the urine in them is much more variable than in acute cases; for the agencies are more complex. In acute diseases, one important factor—the heart's action—is tolerably stable; for, as a rule, during the height of the disease the blood flows more rapidly, and with greater pressure. But in chronic cases the rapidity and force of the circulation are very variable; and, apart from any direct changes in metamorphosis, secretion everywhere must be constantly affected, in different degrees, from this cause alone. Primary digestion also is more variably affected in chronic diseases, and in the same case the amount of food entering the system changes greatly from day to day; whereas in acute cases there is almost uniformly a lessened ingress of nutritive substances. Assimilation also, if less violently disturbed in chronic than in acute cases, is really little less profoundly implicated; and the action of certain organs is sometimes much perverted, or perhaps is even for a time suspended.

Unfortunately, the vast field of chronic diseases has not yet been sufficiently examined. Since the discovery of the easy modes of examining the urine, attention has been directed chiefly to the acute diseases, the great perturbation in which interest the observer at first more than the less obvious, though not less important, mutations of non-febrile affections. But, as far as investigations have yet gone, it would appear that the general condition of chronic disease is a diminished urinary excretion,[1] indicating a lessened metamorphosis from enfeebled circulation, depressed innervation, or deficient ingress of food. This diminution affects both solid and fluid parts of the urine, but especially the former; and of these particularly the urea, the pigment, and the sulphuric acid. The chloride of sodium is generally also lessened, as less enters the system; the uric acid and the earthy phosphates are, on the other hand, less diminished, and may be even normal or increased (Mosler). The frequency of oxalate-of-lime crystals is increased, owing, if a favorite hypothesis be correct, to lessened oxidation. The diminished urinary elimination is sometimes attended by compensatory discharges from the bowels, or less frequently from the skin, or by unnatural discharges from, or diseases of, the stomach, uterus, lungs, or skin, which complicate and to a certain extent alter the course of the primary disease, whatever that may be. In many cases, especially in chronic pulmonary phthisis, these discharges themselves may perhaps react on the urine, and produce still further alterations in it.

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[1] Professor Vogel has some good remarks on this point. Archiv für wiss. Heilk., Band i, p. 130.

I have provisionally divided chronic diseases into two classes:

1. Diseases of organs or tissues.
2. Diseases the origin of which is uncertain, but which are distinguished by prominent urinary symptoms.

DIVISION I.

CHRONIC DISEASES OF ORGANS.

SECTION I.

CHRONIC DISEASES OF THE NERVOUS SYSTEM.

Epilepsy.

In the intervals of the epileptic attacks, no observations have yet been made which show any constant change in the urine. Immediately after an epileptic fit, a large quantity of urine is often passed, which is pale, only feebly acid, and has been said to contain sugar.[1]

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[1] Michea; Reynoso, Comptes Rendus, tomes xxxiii, xxxiv; Goolden; Gibb, Lancet, March, 1855.

Dr. Beale[1] did not detect any sugar in the pale yellow acid urine passed by a child after a fit; and Uhle[2] found none in the urine of two epileptics. Occasionally albumen occurs after the fit.[3]

Hensen has made some analyses of the urine in three men and two women affected with chronic and inveterate epilepsy,[4] and has determined the water, urea, chloride of sodium, and phosphoric acid. The amounts for twenty-four hours do not appear, however, to have been very carefully determined; but numerous analyses were made on the urine of single hours, sometimes for as many as 400 hours. I have calculated, from the figures given by Scherer, the amount for each kilogramme in twenty-four hours, as affording the best means of comparison with other analyses quoted in this work.

One kilogramme excreted, on an average in twenty-four hours, in two men, aged 46 and 40 years, and in one of unstated age, in c.c. and grammes—

	Man of unknown age.	Man aged 46.	Man aged 40.
Water	9·0	18·5	33·6
Urea	0·190	0·269	0·367
ClNa	0·035	0·081	0·108
PO_5	0·015	0·019	0·011

One kilogramme excreted in twenty-four hours, in two women epileptic for many years, in c.c. and grammes—

	Woman aged 30.	Woman aged 20.[5]
Water	9·6	18·0
Urea	0·319	0·315
ClNa	0·154	0·140

On comparing these numbers with those of healthy men and women (see pages 24 and 41), it will be observed that they are considerably below the amounts excreted in health. The deficiency of water is accounted for by the fact that all these patients took very little liquid; they did not seem to care about drinking. Whether the small amount of urea was entirely dependent on the diet (lessened supply of nitrogen), or on retention of urea, is not clear, but it was observed that the urea was increased by the paroxysms.

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[1] British and For. Med.-Chir. Rev., January, 1853, p. 112.

[2] Experimenta de saccharo in urinam, Inaug. Diss., Leipzig, 1852.

[3] Finger, quoted in Medical Gazette, 1848, p. 953.

[4] De urinæ excretione in epilepsiâ, Inaug. Diss., 1859. Quoted by Scherer in Canstatt's Jahresb., for 1859; Band ii for 1860, p. 80.

[5] A little albumen in urine. The diet was very plentiful.

Although the water was thus, on the whole, small, it was subjected to extraordinary variations, which were not dependent on an increased or lessened supply of water, nor were they invariably connected with the attacks. Hensen thinks they were attributable to nervous conditions of the kidneys. All these patients passed more urine during the night than the day.

When the attacks occurred, the water and the urea appear to have been increased; and, like Erlenmayer, Hensen noticed the appearance of uric acid and copious deposits of urates. He could not detect sugar.

Hysteria.

One of the well-known phenomena of hysteria is the large amount of very pale and dilute urine which is passed during or after a fit; it is exactly like the urine passed after copious water-drinking, and yet it is not the consequence of any such large consumption of liquid, nor is it obviously connected with deficient elimination from the skin, lungs, or bowels. No facts are yet known which can lead us to think that before this diuresis there has been any retention of water in the body.

It appears to be caused by a particular condition of the nervous system, which has a parallel in some forms of hypochondriasis and epilepsy, and which occasionally lasts beyond its usual period, and produces continued diuresis. The exact quantity of urine which is passed during this condition is not known, but it is evidently considerable. The urine itself has not yet been analysed. It has been said to contain sugar; but this is extremely doubtful, as the amount of solid matter in this urine is very small (Reynoso, Johnston).

Chorea.

In chorea the urine varies greatly; the amount of water is often lessened, and the urea is relatively large. Whether there is an absolute increase of the urea is not yet known. Beale[1] analysed the urine of a girl, nine years old, who had been ill a month. The amount of the urea (mean of two days) was 210 grains; and, as she weighed 44 pounds, this gave 4·77 grains to each pound in twenty-four hours—an amount not greater than usual. But the case was a mild one. Dr. Bence Jones found an increase of sulphuric acid. Hippuric acid appears to be in very large amount (Lehmann, Pettenkofer, and Duchek). Occasionally, small quantities of sugar are said to be present (Goolden).

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[1] Archives of Medicine, No. 5.

Spinal Paralysis.

In idiopathic and traumatic spinal paralysis, a very frequent alkalinity of the urine was pointed out by Sir Benjamin Brodie.[1] The alkalinity is owing to ammonia; and other observers have connected it almost or entirely with the alkaline secretion of cystitis, or with the ureal decomposition produced by the cystitis which so generally attends spinal paralysis.[2] The extraordinary rapidity with which the urine, when it passes over an inflamed surface, is decomposed, and the very great frequency of slight cystitis in most cases of spinal paralysis, do certainly strengthen this view very much. Heller,[3] nevertheless, believes that the decomposition does not solely proceed from the cystitis, but occurs in cases quite free from any bladder affection, and that, in such cases (which are always fatal) the carbonate of ammonia exists in the blood, and is separated merely by the kidneys. Such instances must, certainly, be very rare, and it is difficult to see how Heller can exclude the possibility of the ammonia having been derived from decomposing urea.

In some cases of spinal paralysis, the urine is very pale, and with slight acidity; it may, indeed, become almost or quite neutral; this is, however, merely a consequence of the lowered nutritive condition, and is not peculiar to spinal disease. Except when medicines are taken, the urine has not yet been proved to be alkaline from fixed alkalies.

On account of the ureal decomposition, the phosphates are precipitated both in and out of the bladder, and there are frequently the evidences of more or less catarrh of the bladder and kidneys.

Albumen does not occur in spine disease without blood.[4]

Valentiner[5] discovered leucin in the urine of an epilectic man who died from spinal injury, but whether this was produced by the epilepsy or the spinal affection is uncertain.

Paralytic Idiocy.

Sanger[6] found, in two cases of paralytic idiocy, the amount of urea lessened (8·48 and 10·97 grammes in twenty-four hours in men; age of one not given; of the other, forty-three years). The chloride of sodium was not lessened. In a third case, a man thirty-five years old, the amount of urea was about normal (28·84 grammes); of chloride of sodium normal, or a little increased. Those patients were on good diet; but Sanger questions whether digestion was good. It is extremely probable that the lowered amount of urea in the first two cases was entirely owing to the diet.

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[1] Diseases of the Urinary Organs.

[2] Rayer (Mal. des Reins, t. i, p. 113) has examined a great number of cases, and found the urine "most often acid when there was no cystitis." Andral (Comptes Rendus, t. xxvi, Juin 19) never saw the urine alkaline without cystitis. So also Bullock (quoted in Heller's Archiv, 1853, p. 435), who also washed out the bladder with warm water, and found the urine then entering acid. In two cases without bladder or renal disease, Becquerel found the urine normal. See also Owen Rees' lectures, in the Medical Gazette, 1851.

[3] Archiv für path. Chem., 1853, p. 436.

[4] Clemens, Deutsche Klinik, 1851, No. 22.

[5] Archiv des Vereins, Band ii, p. 581.

[6] Virchow's Archiv, Band xv, p. 160.

SECTION II.

CHRONIC DISEASES OF THE LUNGS.

Phthisis.

It is rather difficult to find a case of chronic phthisis sufficiently free from disturbing causes, to serve as a typical instance of the disease. Some cases are, in reality, made up of a succession of acute attacks, with intermediate periods of convalescence; others are frequently accompanied with excessive action of one or two of the other eliminating organs; while in some the appetite is extremely uncertain, and the amount of food entering the body varies very much at different times.

When, however, cases are selected in which the disease is running its course equably, and without great hectic, diarrhœa, or dyspepsia, I have been surprised to find the urine apparently almost perfectly healthy, although the lungs were greatly diseased. But diarrhœa, copious expectoration, loss of appetite, or febrile conditions, exert a marked effect on the urine.

Normal Constituents.

1. The water.—Rayer[1] long ago stated that the urine in phthisis is more copious than in other chronic diseases. On checking this remark by my own cases, I certainly find the water to be copious in many instances, in spite too of rather considerable sweating.

The cause of this copious urine is not quite clear; it is certainly not owing to lessened exit of water by the skin and intestines. Is the exit of water by the pulmonary mucous membrane lessened, or is the urinary excess merely owing to a constant thirst produced by the slight pyrexia which often attends even the most chronic cases?

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[1] Mal. des Reins, tome i, p. 64.

The amount of water is reduced by very great, though not by moderate, sweating; it is sometimes lessened by great expectoration, but is most affected by diarrhœa; it then sinks to 30, 20, or 15 fluid ounces per diem, and in one case I found it reduced to 7½ ounces in twenty-four hours. In severe fever the amount falls; and this is the case also shortly before death.

In fits of hectic, however, the amount is sometimes great,[1] especially during the sweating stage. A large amount of fluid is usually drunk, and this will account for some of the excess; but the course of hectic fever closely resembles that of a fit of ague (if the case recorded by Mr. Ringer be a typical one), and it is therefore probable that the hectic fit itself leads to increased watery elimination.

2. The urea.—If the disease is equably advancing, and if the appetite be good, the excretion of urea is regular, and is either natural or a little below the normal. In three of my male cases, with considerable disease of the lungs (softening tubercle), but without diarrhœa, great hectic, or much sweating, the mean excretion of urea for each pound of body-weight was 3·2, 3·5, and 2·8 grains in each twenty-four hours. The experiments were carried on during long periods. The range between the maximum and minimum amounts in these cases was about 12 grammes, *i. e.* 6 grammes (92½ grains) above or below the mean. Brattler[2] records two cases. In a man aged thirty-two (weight not given), with a morning temperature of 98·4 Fah., and an evening temperature of 99·7, and with a pulse of 104, the mean of six days was—

Water.	Urea.	Chloride of sodium.	PO_5.
c.c.	Grammes.	Grammes.	
1422	29·87	13·89	1·158

The urea was remarkably regular in excretion from day to day, scarcely varying more than 1 or 2 grammes from the mean. The amount of chlorine indicates that the appetite was good, and that there was no diarrhœa.

In the second case, a man aged thirty-eight was in the last stage; the amount of urea was in two days 29·16 and 18·06 grammes. Considering the emaciation, and the fact that the appetite (judging from the urinary chlorides = 3·3 grammes) must have been bad, the urea must be considered to be in excess. The evening temperature was 99¼° Fah.; but this is not enough to account for the urea.

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[1] A good case is recorded by Sidney Ringer, Med.-Chir. Trans., 1859.

[2] Ein Beitrag zur Urologie. München, 1858, p. 61.

In two of my cases, I found the amount of urea increased as the patients improved, no doubt from an improvement in appetite. Under the same circumstances the chloride of sodium increased.

During severe fits of hectic, the urea would seem, from Ringer's observation, to follow almost the same course as in ague; in the case examined by him, it fell in amount before the rigors, then rose rapidly, and attained its maximum in the hour preceding the sweating. Its rise was from 1·144 grammes to 1·559 grammes (17½ to 24 grains) per hour.

In cases in which there is intestinal implication or irritability of stomach, the amount of urea varies greatly from day to day. I have known it range in the same case between 37 and 9 grammes in twenty-four hours; and almost always this variation can be traced to vomiting, diarrhœa, temporary anorexia, or effusions into the pleura.

I have been unable to determine whether in these remarkable variations, when the quantity of urea sometimes fall by as much as 230 grains (*i. e.* as if half the body had ceased to form it), the diminution in the urea preceded or followed the associated condition of vomiting, purging, &c.

3. The uric acid is said to be in large amount (Becquerel); but no sufficient examinations have been made. Deposits of urates occur when the water lessens from vomiting, purging, or great sweating.

4. The sulphuric acid in many of my cases has been a little below the mean; but as the appetite was bad in these cases, it was probably owing to this. The variation was not great enough to lead to any supposition of either increased or lessened metamorphosis of the sulphur-holding tissues.

5. The phosphoric acid has not been sufficiently examined. In Brattler's first case (six days) it was very small, viz. 1·358 grammes, or 20·86 grains. The mean amount in healthy men is 3·164 grammes; and the smallest mean amount in any healthy man yet recorded is 1·6 grammes, or 24·7 grains (Introduction, p. 14). Now in Brattler's case the urea and chlorine were in good amount, and there was no want of food. What then was the cause of this very small amount of PO_5? Beneke has affirmed that in all cases of tuberculosis with emaciation, the earthy phosphates are increased. As in Brattler's case the man was improving, was the PO_5 held back for the increasing growth of tissue?

6. The chloride of sodium varies very much, and is influenced by the appetite and the existence of vomiting and purging, as much passes off with the stools (and skin?). Very copious expectoration also reduces it, as the sputa are rich in chlorides.

During the actual fit of hectic, the chlorine, like the urea, increases during the cold and hot stages, and during the early part of the sweating stage. In Mr. Ringer's case, formerly quoted, it rose from 0·468 and 0·357 grammes per hour, before the shivering, to 0·661 grammes per hour in the cold stage, to 0·809 grammes in the hot stage, and to 1·481 and 1·248 grammes per hour in the first two hours of the sweating stage. Had it gone on for twenty-four hours as largely as in the first hour of the sweating stage, no less than 35·5 grammes, or 548 grains, would have been excreted. In the third and fourth hours of the sweating stage, it fell to the normal amount—0·421 and 0·450 grammes; but it is very noticeable that, in this case, great sweating did not reduce it. Indeed, after the fit was over, it rose to 1·020 grammes, and then fell to 0·692 grammes.

As in ague, the chloride of sodium was, in this case, in rather close relationship with the urinary water; the per-centage amount remained tolerably constant, so that, when the water was abundant, the chloride was so also. Yet the relation was not quite invariable.

7. The pigment is variable in phthisis in the same way as is the urea, viz., when perturbing conditions of vomiting, purging, &c., are in action. When the urates fall, they are also often tinted carmine or pinkish; and certainly the pink tint is more common than in other chronic diseases. At present, this alteration in the pigment is the most noticeable point in the phthisical urine. Yet it is often absent, and is most common in hectic.

8. Oxalate-of-lime crystals are said to be very common; but they are so frequent in all chronic diseases, that they cannot be said to be yet proved to be more frequent in phthisis.

Altogether, the condition of the urine in phthisis seems to deviate little from the normal, except under the circumstances already noted.

Abnormal Constituents.

Neither leucin nor tyrosin have been yet detected. Sugar is sometimes present, but is only transitory, as in other cases, except in diabetes with phthisis.

Albumen occurred in forty-six of 186 cases examined by Finger, or in 24·7 per cent. I found it only in one of twenty-eight cases (3·6 per cent.), and in that instance it was temporary. The difference is too great to be accidental. Some error must exist either in Finger's cases or in mine.

Blood, renal epithelium, and casts are occasionally, but rarely, seen in cases without permanent kidney implication.

Spasmodic Asthma.

I do not know any precise observations made on the urine of spasmodic asthma before, during, and after the fit, except in a case examined by Mr. Sidney Ringer, which he has permitted me to use.

The patient was a man aged forty-five, without any other disease. At five p.m. he took a moderate tea. At 1·30 a.m. the paroxysm came on, and lasted violently for an hour, and then less severely till four o'clock. He took no food, drink, or medicine, during the examination. The hourly examination of the urine was as follows:

Hours.	Quantity of urine per hour, in c.c.	Quantity of urea per hour, in grammes.	Quantity of ClNa per hour, in grammes.	Remarks.
7 to 8 p.m.	37	2·701	0·373	
8 „ 9	34	2·631	0·374	
9 „ 10	23	1·831	0·233	Influence of food over.
10 „ 11[1]	23	1·831	0·233	
11 „ 12	23	1·831	0·233	
12 „ 1·30 a.m.	23	1·831	0·233	
1·30 to 2·30	25	1·740	0·285	Fit commenced at 1·30.
2·30 „ 4	20	0·960	0·160	Fit ended at 4 o'clock.
4 „ 8·40	26	1·760	0·306	

The remarkable diminution both of the urea and the chloride of sodium, in the hours immediately succeeding the fit, would certainly imply a considerable arrest either of formation or of elimination, and probably the former; the urea after four o'clock rose to its former amount; the chloride of sodium rose even above the previous quantity.

Emphysema Pulmonum.

It is extremely difficult to find cases of emphysema uncomplicated with bronchitis,[2] lung congestion, heart disease, or hepatic congestion and enlargement. When bronchitis and heart disease are co-existent, the urine is scanty, dark-coloured, and sedimentous from lithates. It has been stated that, on account of the imperfect oxidation in emphysema, the urea is lessened, while the uric acid and the oxalic acid are in excess. I imagine that this belief originated in Lehmann's analysis of the uric acid in his own urine, when he was suffering from emphysema and bronchitis. It was in very large amount. The cases hitherto recorded are certainly insufficient to bear out this statement; apart from acute bronchitis, I have not found any apparent increase in the uric acid, nor has it been proved at all satisfactorily that oxalate-of-lime crystals are more common and abundant than in other chronic cases.

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[1] The urine from 9 to 1·30 was put together to get the hourly amount. I have divided the total amount by the number of hours; so also with the hours from 4 to 8·40.

[2] The cases referred to by Becquerel were evidently of bronchitis.

I have examined one case, in a man, in which, with immense emphysema, causing permanent cyanosis and constant dyspnœa, there was almost an entire absence of bronchitis and heart disease. It was, indeed, a typical case. The appetite was good, and the patient was allowed good diet. The amount of urinary water was very great (116 ounces in twenty-four hours; mean of six days), partly apparently from great dryness of the skin, but partly perhaps from insufficient elimination by the lungs. In accordance with the good appetite, the urea and chloride of sodium were both in quite normal amount (32·25 and 11·75 grammes; mean of six days). The uric acid was either in traces, or was altogether wanting.[1]

In another case (man, aged forty-six) with moderate bronchitis, but with less emphysema than the former case, the urinary water averaged 1030 c.c., or 33 fluid ounces (mean of twenty-four days); the urea 13·29 grammes, or 205 grains (mean of twenty days); and the chloride of sodium 3 grammes, or 46 grains (mean of twenty days). Each pound of body-weight excreted, on an average, 10 c.c. of urine and 2·05 grains of urea in twenty-four hours. The uric acid was not determined in this case. Now here the urea was certainly in small amount, both absolutely and in reference to body-weight; but then the appetite was bad, and little food was taken. As in the first case, with much greater want of aëration, the urea was not lessened, the deficiency would seem here to be more likely to be owing simply to deficient ingress of nitrogen. There was also occasional vomiting, diarrhœa alternating with constipation; and there was sometimes decided sweating.

When considerable bronchitis is combined with emphysema, there does really seem to be a deficient oxidation; the urea is small in amount, uric acid is in large quantity, and oxalic acid is perhaps present in greater abundance than usual, though on this last point the evidence seems to be inconclusive, as the mode of measuring the amount of oxalic acid is so rude.

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[1] This observation was made by Dr. Ranke, and is quoted in his work, Ausscheidung der Harnsaure, p. 31.

On the whole, it may be said that the precise effect on the urine of emphysema sufficiently great to cause permanent dyspnœa and impeded aëration, but yet without pneumonia and bronchitis, has yet to be determined.

SECTION III.

CHRONIC DISEASES OF THE HEART.

As the heart is no secreting organ, its function does not directly alter the *quality* of the blood, and it can affect the urine only by altering the conditions of the circulation in the body at large, or in the kidneys, either by increasing or diminishing lateral pressure, or by altering the rapidity of the flow of blood, or in both ways combined. Several possible combinations are thus given. Increased lateral pressure may coincide with lessened movement, or with greater movement, of the blood; or lateral pressure may be diminished with either of these two conditions.[1]

According to the present physiological doctrines, it is to be presumed that the greatest amount of urine would be secreted when the greatest lateral pressure coincides with the most rapid movement of the blood, and conversely, that the urine will be most diminished when a lessened pressure occurs with a diminished rapidity of flow.

Theoretically, perhaps, this may be correct, but it is not easy to illustrate these laws by reference to cases of heart disease. In the first place, it is extremely difficult, in many cases of cardiac disease, to determine whether or not the propelling power of the heart is altered. It may be assumed, that *every* valvular lesion must be an obstructive cause, and must tend primarily to lessen lateral pressure in the vessels at large. But then this is compensated, in many cases, by hypertrophy and by stronger action of the heart, so that there may be really no alteration in rapidity or in the pressure of the blood.

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[1] The latest special writers on this subject are:

Ludwig, Physiologie, Band ii.
Goll, Henle's Zeitschrift, 1853, Band iv.
Dornbluth, Henle's Zeitschrift, Band vii.
Heynsius, Archiv für Holland Beitrage, Band i.
Westphal, Archiv für path. Anat., Band xviii, p. 509.

But, secondly, when the power of the heart is decidedly weakened, there are almost always complications which bring other physical and chemical conditions into play: the lungs become congested, the liver and alimentary mucous membrane engorged; aëration is diminished, digestion altered, and absorption impeded. How are we to apportion to these various conditions their respective influence on the urine? Dropsy may add another difficulty, and it then would be almost hopeless to determine the exact influence of the cardiac action, although this may have been the starting point of all the subsequent conditions.

A late writer on this subject, Dr. A. Kühner,[1] from an examination of three cases only, came to the following conclusions:

1. "Goll's experiments, according to which the pressure of the blood exerts an essential influence on the excretion of urine, apply in nowise to the valvular affections of the heart.

2. "The amount of the urine is the same in cardiac valvular affections as in all other chronic diseases.

3. "It varies in cases without hydropic complication, within the normal limits, or suffers a moderate diminution.

4. "As soon as dropsy comes on, the amount of urine is regulated in a remarkable way by it, and is to the dropsy in an inverse proportion.

5. "Towards the fatal termination, the amount of urine is sometimes unchanged, in other cases much lessened" (p. 560).

With respect to the influence of dropsy, I believe general experience bears out Dr. Kühner's statement. As to the slight lessening of water in cases without dropsy, I think also that this is correct; but as I have not been able to compare the physiological mean of the individual with the amount passed subsequently, when the heart was diseased, I do not feel certain.

I shall add merely a tabular view of my least complicated cases, as a contribution to the future investigation of this point.

[1] Archiv für phys. Heilk., 1859, Band iii, p. 534.

Amount of urine passed in twenty-four hours, by male patients with cardiac disease.

Age.	Nature of heart disease.	Presumed condition of propelling power of the heart.	Other morbid conditions present. Medicines.	Mean amount of urine in 24 hours, in fluid ozs.	No. of days furnishing the mean.	Mean specific gravity.
28	Aneurism of arch of aorta. Valves healthy. Left ventricle small . . .	Feeble—quickened (116—120) .	None . .	41	6	1020
50?	Aneurism of arch of aorta. Left ventricle hypertrophied	Moderately strong, 80 per minute .	None . .	31	12	—
—	Obstruction at aortic orifice. Mitral regurgitation. Hypertrophy of left ventricle	Supposed to be lessened . .	Emphysema. Enlarged liver. Anasarca. Salines . .	31 (anasarca) 65 (anasarca disappearing)	5 9	—
70	Obstruction at aortic orifice. Mitral regurgitation. Hypertrophy of left ventricle.	Supposed to be lessened . .	Anasarca . .	44	6	1017
11	Mitral regurgitation. Hypertrophy of left ventricle .	Apparently strong, pulse full, 68 .	No complication	38	7	1018
23	Obstructive and regurgitant aortic disease. Hypertrophy of left ventricle .	Strong action, pulse 92 . . .	No complication. Digitalis. Salines . .	28	16	1031
—	Obstructive aortic and regurgitant mitral disease. Hypertrophy of left ventricle	Moderately strong action, pulse 92 .	No complication. Salines for 2 days, then digitalis . .	48	7	1025
20	Aortic obstructive and mitral regurgitant disease. Slight hypertrophy of left ventricle	Moderate action .	No complication. Digitalis (tincture for 2 days), then digitaline (1-120th of a grain 3 times daily) . .	34	12	1019

Excluding the case of anasarca and diuresis during the removal of dropsical fluid, it will be seen that in no case was there excess of water, and that, in several, there was slight diminution; the mean of the whole is 38 fluid ounces. There are, however, healthy persons whose excretion is less than this. (See Introduction, p. 5.)

If pressure reaches a certain point in the renal circulation, albumen occurs in the urine; at least, this seems to be the explanation of those undoubted cases of cardiac dropsy, in which the albuminuria is transient, or is unattended by the slightest trace of kidney disease after death. Yet cases occur of very enfeebled beat, producing, apparently, almost complete stagnation of the circulation, without giving rise to albumen, although the effused dropsical fluids may contain albumen to a considerable extent.

The action of the heart is a complicating element in all diseases, and it is not easy to assign its precise effect. It may alter the urine by interfering with the circulation in the liver, lungs, or other parts; and, therefore, altering metamorphosis. But these effects must be considered under the headings of the various organs whose circulation is thus altered.

SECTION IV.

CHRONIC DISEASES OF THE LIVER.

The condition of the urine in *fatty* and *lardaceous*[1] enlargements of the liver is not yet known. The latter disease is seldom pure, but is combined with lardaceous affection of the kidneys and spleen, and intestinal mucous membrane.

Cirrhosis.

In *congestions* and in *interstitial inflammations* of the liver, leading to contraction (cirrhosis), the urine is affected in a twofold manner.

1. Mechanically; for the lessened circulation of congestion, and the compression of vessels in cirrhosis, diminish the absorption of water from the stomach and intestines, and the amount of urine is always lessened in amount.[2] The lessened amount of urine is so constantly indicative of hepatic obstruction, that a constant copious or even natural flow is a strong argument against the existence of any material amount of congestion or cirrhosis.[3] Diuretics necessarily act with great difficulty and uncertainty in this condition, and, indeed, will often not act at all, until the congestion of the liver (which may, for the time, augment the effect of cirrhosis) has been removed by purgatives.

The effect of the lessened water is to cause the urine to assume the "so-called febrile" characters; it is high-coloured, acid, and deeply tinged urates are frequently deposited. The acidity increases rapidly after emission.

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[1] The scrofulous enlargement of Budd.

[2] This is not noted in fatty or lardaceous disease, because the circulation is little affected; for although the vessels may be thickened in the latter disease, their calibre is not generally altered. It is not usual, either, in cases of cancerous liver.

[3] Budd records a most remarkable case (3d edition, p. 165), in which a man with large and hobnailed liver had ascites and distension of the abdominal veins. There was, however, in addition, saccharine diabetes, and no less than 10 to 12 pints of urine were passed in each twenty-four hours, without any lessening of the ascites. In this case, water must have passed through the vena portæ, and yet the ascitic fluid could not do so.

2. The other effect produced by congested and cirrhotic livers is chemical; whatever may be the cause, it seems certain that abnormal pigments are generally present in the urine, to which they give a dark-reddish, brown, or gray, or even blackish colour, and often tint the urates of a dark-red, or brown-carmine, or pink colour. Unfortunately, the great difficulty of isolating the pigment has prevented a very accurate examination; but Scherer's experiments imply that the amount of carbon is increased. These pigments are evidently closely connected with bile pigment in composition; and even when there is no jaundice, biliphœin may be detected in the urine[1] by evaporation, solution in alcohol, and the application of the usual tests, or by digesting the precipitate produced by diacetate of lead, in spirit acidulated by hydrochloric acid.

So frequent is the occurrence of abnormal pigments in the urine in this condition, that Dr. Golding Bird[2] has suggested their occurrence as assisting the diagnosis between ascites dependent on peritoneal and hepatic disease. I believe that this is correct to a considerable extent, though the occurrence of febrile symptoms in chronic peritonitis may produce a resemblance to the urine of hepatic affections.

The mode of origin of these colouring-matters is not known; it used to be said that they "were an evidence of the kidneys performing a compensatory function for the lungs or liver,"[3] in the excretion of carbon; but not only is no carbon ordinarily excreted by the liver, but the kidneys have no such compensatory function,—they are simply separating organs, and the occurrence of abnormal pigment in the urine merely proves that abnormal pigment is in the blood.

The utmost that can be said at present is, that any detention of blood in the liver leads to an excess of dark-coloured and, perhaps, highly carbonaceous pigment in the urine. That the metamorphosis of blood-cells leads, in part, to the production of urine-pigment and of bile-pigment is now generally admitted;[4] and if so, the occurrence of excess of pigment in hepatic, congestive, and cirrhotic affections would imply a more rapid and, perhaps, perverted metamorphosis and destruction of blood-cells in the liver. It is possible that the amount of pigment may be an exact measure of this destruction; but an accurate method of determining this point is not easily to be obtained.[1]

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[1] Just as great jaundice arises from obstruction to the ductus communis choledochus; so the jaundice of cirrhosis may occur from implication of and pressure on some of the larger ducts by the exudation. Gradually as the parts fall together, and become atrophied, the secretion of bile in the portion of liver ceases, and the biliphœin again disappears from the blood and urine.

[2] Urinary Deposits, 4th edition, p. 281.

[3] Golding Bird, ibid., p. 184.

[4] See especially the experiments of Kühne, Valentiner, Zenker (Virchow's Archiv, Band xvii, p. 562), and of Mettenheimer (Correspondenz Blatt des Archiv für wiss. Heilk., 1859, December, p. 622), who has shown that hæmatoidin crystals may come either from bile or blood pigment.

The other constituents of the urine in cirrhosis of the liver vary considerably, because, in different cases, the amount of food taken into the stomach and digested is very variable; the mucous membrane of the stomach is sometimes profoundly implicated in cirrhosis, and impaired digestion is added to impeded absorption. When this is not the case, however, the amount of urea does not seem to be much altered. The uric acid, on the contrary, seems to be generally in large amount.[2] The amounts of the chloride of sodium and the phosphoric acid have not been sufficiently determined. If there be ascites, the effusion is rich in chloride of sodium, and the urine is poor in it.

Very frequently, crystals of oxalate of lime are mixed up with the sedimentary urates. Redenbacher[3] has examined the urine in two women, aged fifty-one and thirty-eight years, for five days each. In each case paracentesis was performed between the first and second observations; the amount of water and of urea increased after the operation beyond the amount it had stood on the first day. Yet, even with this, the mean amount in each twenty-four hours of five days was—

	Water.	Urea.	ClNa.
	c.c.	Grammes.	Grammes.
In the first case	643	22·5	1·8
In the second case	606	14·2	1

The great diminution in the water is very marked, and the same fact is seen in the chloride of sodium, which was, doubtless, in large amount in the attendant ascitic fluid. The urea would not appear to have been much lessened, considering the sex, age, and probable diet of these patients. But the experiments are very few.

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[1] The resemblance between the outward appearances of the urine and hepatic congestion and contraction, and general febrile diseases, is very remarkable; in both there is lessened water and heightened pigment.

[2] Sometimes, in deeply pigmented urine of this kind, nitric acid and heat produce no change, except that of increasing the depth of colour. On cooling, however, a precipitate appears, which is sometimes made up, as stated by Golding Bird, of uric acid, but often is constituted in great measure by an amorphous, dark-coloured substance, which appears to me to be modified pigment. It is not albumen.

[3] Inaug. Diss., quoted in Schmidt's Jahrb., 1859, No. 10, p. 8.

Non-febrile Icterus, from obstruction.

Normal constituents.

1. In most cases of icterus there is a complex condition; for not only is the exit of bile impeded, but the circulation through the liver is also slow. The urine is, therefore, often scanty—though this is not necessary; and in some cases the water is normally abundant.

2. The urea is generally lessened (Scherer, Kölliker, and Müller); it is not certain whether this is dependent simply on imperfect digestion, or whether there is actual lessening of general metamorphosis. The uric acid is often increased;[1] the SO_3 is little affected; the condition of the phosphoric acid is uncertain; hippuric acid fails entirely;[2] the amount of pigment cannot be known, as it is concealed by bile-pigment. The urine is always acid; and, after emission, the acidity increases rapidly, as in congestion of the liver.

The following case, examined by Kölliker,[3] is the most complete determination of the urea yet made in jaundice.

A woman, aged twenty-five, weighing 53·55 kil., with catarrhal icterus.

In each twenty-four hours there were excreted in c.c. and grammes—

	Quantity	Specific gravity.	Urea in 24 hours.	Urea to 1 kilogrm.	SO_3 in 24 hours.	SO_3 to 1 kilogrm.
	c.c.					
Icteric period—16 days ...	1670	1015·3	20·45	0·381	1·714	0·032
Convalescence—9 days ...	1401	1019·4	19·92	0·371	1·508	0·028
Health—7 days	1370	1022·3	26·74	0·499	1·898	0·035

Either, then, the diet was small in amount, or the formation of urea was greatly lessened.

The most marked conditions in jaundice appears then to be, as far as the normal constituents are concerned—1, lessening of the urea; 2, increase of uric acid; and, 3, disappearance of hippuric acid. The condition of the urinary pigment is uncertain.

Abnormal constituents.

Albumen is seldom found in simple cases.

Sugar is absent.

Leucin and tyrosin, and their derivatives, have not been indicated in simple non-febrile jaundice, though they exist in the blood. Taurin appeared to be obtained in small quantities, in one case, by Frerichs,[1] but the observation is not conclusive.

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[1] Becquerel, who noted as much as 1·1 gramme (17 grains). Kühne also (Virchow's Archiv, Band xiv, p. 320) has directed particular attention to this fact. The amount of increase is not known, but seems considerable.

[2] Kühne, loc. cit.

[3] Würzburg Verhandl., 1856, pp. 491 and 497.

Bile-acids.—Before the experiments of Strecker had elucidated the composition of the bile, Orfila and others believed they had found the so-called resinous bodies of the bile in ictericurine. Subsequently, however, it was supposed by almost all observers, that though the bile acids could sometimes be discovered, this was uncommon, and generally they appeared to be entirely absent (Thenard, Chevreul, Lecanu, and in recent times, Lehmann, Gorup-Besanez, Scherer, Frerichs). It was imagined either that, usually, these acids were destroyed in the system, or that the liver in icterus ceased to form them, though it continued to form pigment.

Lately Kühne,[2] making use of a new process devised by Hoppe, states that he has succeeded in getting Pettenkofer's test at all periods of a long case of icterus. Hoppe also noted the reaction in another case, and Sander in others.[3] Kühne has found it also in the urine of dogs, in whom icterus was artificially excited. It would appear that this reaction was owing to cholalic acid, and not to glycocholic or taurocholic acid. Folwarczny[4] has lately repeated Kühne's experiments, but did not succeed in detecting the bile-acids or their derivatives.[5] All these observations must, therefore, be repeated.

Bile-pigment (biliphœin (or cholepyrrhin) and biliverdin) passes in large quantity into the urine, and sometimes assumes dark-purple or, on exposure, even bluish tints, as if some indigo were formed.

To account for the frequent presumed failure of the bile-acids, and for the fact that, when present, there is a very small quantity of the bile-acids in deep-tinted icteric urine, while in slightly tinged icteric urine they are often in greater quantity, Frerichs and Staedeler[6] have advanced the remarkable conjecture that the acids are capable of being changed into the pigment, either in the blood or in some organ. They allege in support of this view, that the glycocholate of soda and glycocholic acid give coloured bodies, when treated with sulphuric acid at varying temperatures, and that a body giving the characteristic bile-pigment reaction with nitric acid can be obtained from taurocholic acid. They also found that, when the bile-acids were given to a dog, bile-pigment generally appeared in the urine, while the acids could not be detected there.

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[1] Leber Krankheiten, p. 102.

[2] Virchow's Archiv, Band xiv, p. 310. A very good abstract of this paper is given by Dr. George Scott, in Beale's Archives of Medicine, vol. i, p. 342.

[3] Deutsche Klinik, 1860, No. 4.

[4] Schmidt's Jahrb., 1859, No. 12.

[5] Frerichs and Valentiner have vainly sought for the bile-acids in the icteric blood (Frerichs, Leber Krankheiten, 1858, p. 100), but these experiments now require repetition.

[6] Müller's Archiv, 1856, p. 55, and in Schmidt's Jahrbucher, 1856, Mai, p. 147.

Kühne[1] states, however, that bile-acids *can* be detected in the urine after injection into the veins, though he confirms the statement that, after such injection, bile-pigment appears in the urine.

Kühne does not attribute this to transformation, but seeks to find the source of the bile-pigment in the destruction of the blood-corpuscles (of mammalia and of birds[2]) which is produced by the alkaline salts of cholalic acid or choloidinic acid. This destruction is so great in some cases of injection of these salts into the blood, as to bring on hæmaturia. An absolute transformation of hæmatin into bile-pigment has, indeed, perhaps not yet been chemically proved; but the close connection between the two bodies is well known (Valentiner, Zenker, Mettenheimer), and some experiments of Kühne, in which glycocholate of soda and hæmatin were injected together into the blood, render such a conversion highly probable. Indeed, Kühne conceives himself entitled to conclude that, in his experiments, " blood-pigment was changed into bile-pigment, and that an, as yet inexplicable, influence in this direction must be attributed to the bile acids."

Kühne[3] has made the remarkable observation, that not only does hippuric acid fail in icteric urine, but that benzoic acid, given by the mouth, does not, as usual, appear as hippuric acid in the urine, but passes off unchanged.[4]

Kühne concludes from this observation, that no glycin can be formed in the icteric liver, otherwise the benzoic acid would have appropriated it; and he surmises that only taurocholic, or perhaps cholalic, acid is formed, instead of glycocholic. By experiments on dogs, he found, in fact, that the urine contained cholalic acid, but no conjugate acids.

If this be correct, it may be conjectured that there comes a time when no glycocholic acid (*i. e.* no glycin) is formed, and this would imply a perverted metamorphosis in the liver.

Taurin, however, may not be deficient, as this has been apparently found in the urine by Frerichs, as already stated, though Kühne could not find it. It is evident that this subject is at present in a state of great confusion, and that a complete re-examination is necessary.

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[1] Virchow's Archiv, Band xiv, pp. 321 and 330.

[2] Not for the blood-cells of frogs; at least, not in spring (Kühne).

[3] Virchow's Archiv, Band xiv, p. 321.

[4] The statement, however, has been contradicted by Folwarczny (Schmidt's Jahrb., 1859, No. 12), who, after giving benzoic acid to patients with icterus, obtained crystals from the urine, which he regards as hippuric acid.

Cancer of the Liver.

The urine seems to be extremely variable; often it is scanty and pigmented; sometimes, especially in the last stages, it is copious, pale, and deficient in urea. This has evidently depended, in my cases, in great measure on the utter failure of digestive and nutritive power. In a woman with enormous hepatic cancer and profuse diarrhœa, A. Vogel[1] found the urine very copious, with little pigment, &c.; in each twenty-four hours, there were only 7·92 grammes (122 grains) of urea.

SECTION V.

DISEASES OF THE SPLEEN.

No observations have yet been made on the urine of splenitis, or acute splenic congestion, apart from malarious fevers.

In the chronic enlargement of the spleen consequent on ague, the amount of uric acid is said to be increased. The pigment also is in large amount (Golding Bird). No exact analyses have, to my knowledge, been yet made.

Leukæmia, or Leucocythemia.

Very few complete observations on the urine have as yet been made.[2] In a case very carefully recorded by Thierfelder and Uhle,[3] in a man aged twenty-one, the mean of the observations was—

Daily excretion of urine (128 days)	2095·7 c.c. (= 67 ozs.)
Daily excretion of urea (126 days)	36·4 grammes = 562) grains).[4]
The body-weight was 67·5 kil.; so that 1 kilogramme excreted	31·03 c.c. of urine,
„ „ . .	0·539 grammes of urea,

in twenty-four hours, which, if the man was feeding well, is not, or is very little, beyond the healthy amount of urine and urea.

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[1] Henle's Zeit., Band iv, p. 362.

[2] See Bennett, on Leucocythemia, for all the scattered observation up to the date of publication.

[3] Archiv für phys. Heilk., 1856, p. 441.

[4] The chlorides were not, however, separated; so that this number is too high.

Traces of albumen were noted on several occasions; and there were frequent sediments of urates, in spite of the amount of water. At a later period of the case, when the chloride of sodium was determined, its mean amount was 15·29 grammes, or 236 grains.

The number of white corpuscles was as one to six of red, in the beginning of the case, and as one to three at the latter period.

The amount of urine diminished considerably during the progress of the case, but rose again about five weeks before death. The spleen weighed 3155 grammes (6·95 lbs. avoir.).

In a case, in a thin woman, aged sixty-nine, which occurred to me some years ago,[1] the urine was also copious (60 to 100 fluid ounces) and pale; in spite of the amount of water, there were deposits of pale urates; it contained albumen occasionally, and once a little bile-pigment. It was analysed on one occasion, with the following result:

The urine of twenty-four hours.

Quantity	90	ounces
Specific gravity	1026·5	,,
Urea	427·5	grains
Uric acid	31·5	,,
Pigment and extractives	493·2	,,
Soluble fireproof salts	407·7	,,
Earthy salts	23·4	,,
Albumen	81·0	,,
Total solids	1414·3	,,

The amount of uric acid in this case was enormous (both absolutely and in comparison to the urea—as 1 to 13, nearly), and the quantities of extractives and salts were also very great.[2]

The condition here was remarkably similar to that in the case lately observed by Thierfelder and Uhle.

Scherer discovered hypoxanthin in the urine, as well as in the blood; an observation which is highly important, in consequence of the relationship of hypoxanthin to uric acid.

In a case of Dr. Walshe's (a woman, aged thirty, weight 46·2 kilogrammes), in which the urine was analysed by Ranke,[3]

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[1] See Clinical Lecture, in Medical Times and Gazette, June, 1850, for a fuller account of this case.

[2] An analysis of the blood, made five days before, had shown a large increase in the fibrine (7·08 per 1000) and of the soluble salts of the serum (9·68 per 1000 of serum), a great lessening of the red corpuscles, and some lessening of the albumen. Uric acid was not detected in the serum. This analysis was made before those of Scherer; and the existence of hypoxanthin was not known to me at the time. No salts were given as medicine, but the appetite was good, and the diet plentiful.

[3] Ausscheidung der Harnsaure. München, 1858, p. 23.

(11 days), the uric acid was also increased (0·915 grammes) absolutely and relatively to the urea and solids (1 to 21 and 1 to 29·5). The urea was not increased (19·49 grammes); the chloride of sodium was 3·34 grammes; and, as the amount of the total solids was small (26·37 grammes), there was none of the increase in the extractives and salts noted in my case.

One kilog. excreted in 24 hours, of urea . .	0·421 grms.
„ „ „ uric acid	0·020 „
„ „ „ solids .	0·570 „

The increase of the uric acid in leukocythemia is then rendered almost certain, and it is impossible to avoid believing that there is some connexion between this and the enlarged spleen. The presence of hypoxanthin in the blood and urine renders this still more probable.

SECTION VI.

CHRONIC DISEASES OF THE STOMACH AND INTESTINES.

Under the vague but convenient term of *dyspepsia* are arranged a number of symptoms which are dependent upon very different causes, some functional and some structural.

Instead of attempting to describe the condition of the urine, as in simpler and more easily isolated diseases, I shall merely enumerate the various states in which the urine may be found.

1. Quantity.—As a rule, perhaps, the urine is not lessened in quantity, unless there be either great vomiting or hepatic congestion.

2. Acidity.—Alterations in free acidity are at present the most important signs connected with the urine.

The normal condition of the urine during digestion may be considered to be (after Bence Jones) a lessening of acidity. In some dyspeptic persons, however, the acidity of the urine after food is said not to follow this rule, but to increase. If so, there would either be a deficient supply of acid to the stomach, so that more is excreted by the urine, or there is a production of abnormal acid. The experiments, however, are so few in number, and have been so incompletely made, that it is unsafe ground for conjecture.

In some dyspeptic cases, especially those attended with torpid digestion or with acid vomiting (Bence Jones), it has even seemed to me that the urine is more alkaline than usual. At least, without the food being apparently richer in alkaline substances, I have seen the urine passed two or three hours after a meal so alkaline from fixed alkali that the earthy phosphates were largely precipitated; much more largely, in fact, than I have ever seen in health. Are there, then, two conditions of the urine in dyspepsia—abnormal acidity and abnormal alkalinity?

When the urine is more acid than usual after food, it is also often scanty, and deposits urates and oxalate of lime. The symptoms connected with this state are chiefly cardialgia, nausea, and frontal headache.

3. Colour.—The alkaline urine is usually pale; the acid urine is deepish in colour, perhaps, however, merely from concentration.

4. Urea.—The amount of urea depends upon the power of digestion. Sometimes it is very small. Often, however, it is relatively large in the acid urina cibi, as the water is lessened.

5. Uric acid.—It is often great in the acid urina cibi, and is said by Lehmann to be increased absolutely as well as relatively; but quantitative determinations are still wanting. Dr. Prout thought that badly and half-digested food gave rise to a large amount of uric acid.

6. Chloride of sodium.—The amount depends very closely on the amount of food and digestion; it is small when digestion is imperfect, and, as a rule, it would appear that the more chloride is in the urine, the more perfectly must it be presumed that digestion has been carried on.

7. The amounts of the sulphuric and phosphoric acids have not been determined; both are probably influenced by the very variable amount of food taken in different cases.

8. Abnormal ingredients are not necessarily present. Albumen has been said to occur after certain kinds of indigestible food;[1] but further evidence is required on this point. Sugar also has been found in some instances.[2] Oxalate-of-lime crystals are, perhaps, more common than in other chronic diseases.

Organic Diseases of the Stomach and Intestines.

Very little is yet known on this point. The ingestion of food is often interfered with, and there may be vomiting, which lessens the water of the urine. In a woman aged thirty-nine, with carcinoma of the stomach, Brattler found (mean of two days) only 17·7 grammes of urea, 2·44 of ClNa, and 1·05 of PO_5.

It has been pointed out by Dr. Barlow, that intus-susception or strictures in the intestines high up, cause a lessening of the amount of urine from, it is presumed, deficient absorption. This has been proposed by Dr. Barlow as a means of diagnosis, It is certainly a point worthy of great attention; but I am not aware that any number of observations have been made on the point.

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[1] Eggs in very large quantity; a large amount of cheese and pastry.

[2] Christison, Monthly Journal, Jan., 1851.

In *diarrhœa* the same effects occur as from the action of purgatives; the water and the chloride of sodium are diminished;[1] the urea is less affected, though, as there is usually abstinence from food, it falls in amount from this cause.

SECTION VII.

CHRONIC DISEASES OF THE SKIN.

No analyses of the twenty-four hours' urine have yet been made, of the urine of the chronic cutaneous eruptions common in this country. In the elephantiasis Græcorum (tubercular and anæsthetic leprosy), the urine has been examined by Boeck and Daniellsen. It is very frequently albuminous.

In boils (when there is, however, often considerable fever), it has been supposed that sugar is not infrequent in the urine. That boils are rather frequent in diabetes is well known; but Garrod's observations[2] seem to show that the frequency of the appearance of sugar, as secondary to boils, has been overrated. The observations lately made on the sugar in healthy urine render a complete reinvestigation desirable.

SECTION VIII.

CHRONIC DISEASES OF THE BONES.

Rickets.

Both Lehmann[3] and Beneke[4] have found a very great increase of the earthy phosphates (the constituents of bone) in the urine.

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[1] Moos, on Catarrhus Intestinalis a-febrilis, op. cit.

[2] Gulstonian Lectures, 1857, British Med. Journal.

[3] Lehrb. der phys. Chem., 2d edit., Band ii, p. 397. In a rachitic child of four years old, Lehmann found no less than 0·496 grammes, or 7·65 grains, of earthy phosphates in each twenty-four hours. Neubauer's mean for adult men is 0·944 grammes.

[4] Zur phys. und path. des phosph. und oxal. Kalkes. Gott., 1850.

This is no doubt connected, in these cases, with the increased metamorphosis of bone, from whatever cause this may proceed. It has not yet been shown, however, that this is universal, and rickets may be connected sometimes with simply deficient ingress of the earthy salts, without altered egress; and it must also be said that neither Lehmann nor Beneke carried on their analyses over a sufficient number of days.

Gorup-Besanez[1] in one case discovered lactic acid in the urine, and this has given rise to the hypothesis that an undue amount of lactic acid in the body dissolves and carries out the earthy salts. Lactic acid, however, does not appear to exist in the diseased bones, and a single observation on the urine is of little value. Lehmann has noticed oxalate of lime in the urine of rickets; but as crystals of this salt are common enough in children's urine, no conclusions can be drawn from the fact, although it happens to harmonise with Beneke's hypothesis that the oxalic acid is the solvent of the earthy phosphates.

In *mollities ossium*, a peculiar protein substance was discovered by Bence Jones to exist in large quantity in the urine. (See page 189.) Unfortunately, no other analyses of urine have yet been made, to my knowledge.

SECTION IX.

DISEASES OF THE BLOOD.

The urine, derived immediately from the blood, must accurately reflect its constitution; but comparative analyses of the blood and urine in the same case have not yet been made in sufficient numbers. Our knowledge, therefore, of this important subject is very scanty. The diseases of the blood, with diminution of the red corpuscles,[2] viz., *anæmia* and *chlorosis*, are attended with one constant urinary character, viz., a diminution in the urine-pigment, which is often reduced to one fourth or one sixth of its normal amount. There is also, very generally, a lessening of the free acidity; and urine, which is pale and almost neutral during the whole of the twenty-four hours, is almost as good an indication for the use of iron as the pallor of the skin itself. The amount of iron in the urine of anæmia is often very small,—a fact which supports Harley's view, that the iron is in combination with the pigment, and does not exist as a salt.

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[1] Canstatt's Jahresb., 1849, Scherer's Report on Path. Chem., p. 41.

[2] Diseases included in the Oligocythæmia of Vogel. I have used here the term anæmia in its usual sense, to imply simply lessening of the number of blood-cells.

The quantity of urine is often not decreased, or is even large. The specific gravity is low.

Little is yet known of the amount of the other normal ingredients. In many cases the urea is not much decreased, although, from the paleness and the low specific gravity of the urine, and the general weakness and depression of the system, such a decrease would have been anticipated. The large amount of urine compensates, however, for the lessened specific gravity. The uric acid is in small amount. The amount of the SO_3 is variable. Heller found it lessened. Gruner noticed a mean excretion of only 1·12 grammes, or 17 grains, in twenty-four hours, in a girl (age not stated), whose weight was 85 pounds. On the other hand, Lehmann has found it increased to an enormous amount, as much as 3·517 grammes, or 54 grains. I have also noticed, in one case, an amount of 30 grains in a girl aged nineteen, on very moderate diet. The amount of the PO_5 is uncertain.

As respects abnormal constituents,—albumen is uncommon, and sugar has not been noticed. An interesting observation was made, several years ago, by Shearman, of Sheffield, that cystine appears more frequently than would be expected in the urine of chlorosis. It is not known whether this is constant or common; but the occurrence of the sulphur-holding substance may have some bearing on the occasional enormous quantity of SO_3 noticed by Lehmann. Tuel has lately recorded two cases of the passage of cystine with the urine; both patients were women, and both were chlorotic. (See "Cystine.")

The condition of the urine corresponding to the other quantitative changes in the blood, viz., increase, decrease, or alteration in quality of the fibrine,[1] albumen,[2] fat, and salts, is not yet known, as these states cannot be diagnosed as primary and independent affections at present. We only know, that in the diseases attended with great increase of fibrine (pneumonia and acute rheumatism), the SO^3, the urea, and the uric acid are greatly increased; that in hypalbuminosis the amount of urea is small, as in the convalescence of fevers; that excess of salts in the blood generally appear in the urine; and that, in excess of water of the liquor sanguinis (hydræmia), the water of the urine is generally large, unless there be, as is often the case, escape of water from other channels (dropsy of cavities or of the areolar tissues). The condition of the urine in diseases attended with accumulation of morbid substances in the blood (sugar, oxalic acid, ammonia, &c.) is considered in other pages).

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[1] Hyperinosis and hypinosis.

[2] Hyperalbuminosis and hypalbuminosis.

DIVISION II.

DISEASES OF UNCERTAIN ORIGIN, BUT WITH PROMINENT URINARY SYMPTOMS.

Many of the diseases of this class are obviously produced by alterations in the nutritive process, either in the stomach, in organs, or in the blood. They form, however, a complex class, and are united here by the convenience of arrangement, and not by any similarity in origin. They all have, however, one marked feature. One of their principal symptoms is a peculiar urinary condition, and, therefore, they have been often included among the diseases of the urinary organs.

Their urinary symptoms consist either in the appearance of some abnormal substance, as sugar, cystine, or in the disproportionate increase of some normal constituent, such as water or urea.

SECTION I.

URINE CHARACTERISED BY EXCESS OF SUGAR.[1]

DIABETES MELLITUS. GLUCOSURIA. MELLITURIA.

There is, perhaps, no disease more interesting than this; it is connected with those conditions of nutrition which have been lately investigated most fully by physiologists, and, although our knowledge of the essence of diabetes is not great, we are now tolerably well acquainted with its phenomena, and their order of succession.

Normal constituents.

1. Quantity of urine.—In the great majority of cases the

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[1] There is reason for thinking that a little sugar may occasionally appear in the healthy urine, but the excessive quantity of diabetes is entirely pathological.

quantity of urine is greatly increased; 100, 200, 400 ounces, or even larger quantities, are passed in twenty-four hours. In exceptional cases with a transitory or permanent slight amount of sugar, the quantity may not be more than normal. To supply this quantity of water, a corresponding amount of fluid is drunk.

The amount passed is sometimes so great, as to have led to the opinion that the fluid drunk was insufficient to account for the amount of urine.[1] If this be correct, one of these explanations must be given:

1st. Either the body becomes poorer in water, and loses weight.

2d. Or, water is absorbed by the skin and lungs.

3d. Or, water is formed in the body by direct union of its elements (suggested by Lavoisier).

Now, on considering these cases of supposed greater egress than ingress of water, it is at once apparent that, in some instances, the observations were not carried on long enough; and that, in other cases, sufficient care was not taken to measure accurately the amount of water in the solid food. Besides, it may be questioned whether, in some instances, the patients could be trusted. The incontrollable thirst of diabetics often leads them to drink suddenly, if water be accessible, and possibly without stopping to measure what they take.

It must also be admitted, that the more carefully experiments are made, the less often do cases of excess of urine over fluid ingesta occur. In many instances (Vogt, Pfeuffer, Lowig, &c.), the fluid taken as drink certainly surpasses that passed by the kidneys; why should this be different in other cases?

I select two or three of the last recorded cases of diabetes, as being likely to be most correct.

Nasse,[2] to determine this point, made observations on two patients for eight days each; the fluid parts of the solid food being, of course, taken into account; and the patients were secluded, so that they could only take the fluid actually given to them.

First case, in eight days:

Water taken . .	1256 ounces.
Urine passed . .	983 „

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[1] Dupuytren, Thenard, Bardsley, Christison, Contour (Du diabète sucré, Paris, 1845). A case has been very carefully recorded by Ormerod (Edin. Med. and Surg. Journal, Jan., 1847). In twenty-eight days, 900 oz. more fluid urine passed by the kidneys than could be accounted for by food and drink. This patient gained weight!

[2] Archiv für phys. Heilk., 1851, Heft i, p. 72.

Second case, in eight days:

Water taken	997 ounces.
Urine passed	738 „

Von Dursch[1] gives the following two cases.

1. Fluid taken in twenty-four hours:

Drink and fluid food	4615 grammes.
Fluid in solid food	605 „
Total	5215 „

Fluid passed—

Urine	4920 grammes.
Skin and lungs	198 „
Intestines	92 „
	5210

Thus, the ingress and egress of water was nearly equal.

2. Fluid taken in twenty-four hours:

Drink and fluid food	4900 grammes.
Fluid in solid food, uncertain, say	600 „
	5500 „

Fluid passed—

Urine	6216 „
Skin and lungs	204 „
Intestines	94 „
	6514

In this case there appeared to be an excess of water passed, but the amount of the fluid in the solid food was uncertain; besides, Von Dursch mentions that the patient could not be relied upon.

Rosenstein,[2] from a careful examination, also came to the conclusion that the quantity of urine is less than the quantity of water taken in liquid and solid food.[3]

I have made some experiments on this point, and believe that the quantity of fluid taken will surpass that excreted, if long periods (ten or twelve days) are taken for the examination. A fallacy is, however, produced by the curious fact that water is often retained for some time in the body of diabetics; and if an observation be made in a single day, it may happen that some of the urine retained from the previous day is then poured out. It is not impossible that water may be sometimes retained for longer periods, and this would account for the excess of urine over drink, noticed by Christison, Pucheltz, Guitard, and others.

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[1] Zeitschrift für rat. Med., N. F., Band iv, p. 1.

[2] Virchow's Archiv, Band xii, p. 414.

[3] So also Vogt, and Pfeuffer, and Lowig, quoted by Von Dursch.

We may, therefore, conclude that at present there is no reason to think either that water is absorbed or formed in the body. Occasionally, no doubt, the body may for a time lose more water than it receives; it will then lose weight.

Almost all the water drunk passes off by the kidneys; the enormous diminution of the insensible perspiration is shown by the figures already quoted from Von Dursch. Instead of 1000 or 1200 grammes passing off by those channels, only 200 passed off. In a case examined by Böcker, the insensible perspiration (skin and lungs) was 529 grammes, which is also less than half the normal amount.[1]

In a case of Mosler's,[2] it was 637 grammes.

The intestinal excretion of water is also lessened, though in a less degree.

That diabetics, drinking water, do not pass it nearly so soon as persons in health, was shown by Falck.[3] If taken in the morning, the urine may not be increased till mid-day. Falck justly refers this to delayed absorption; Beneke has suggested that the delay is owing to the strong attraction for water of the grape-sugar formed in the stomach during digestion. When to the breakfast of diabetics grape-sugar is added, the urine is passed as rapidly as in health.

The retention of water in the system is noticed not only with simple, but with alkaline and mineral waters, like those of Carlsbad.[4]

Urea.—Very great discrepancies of statement exist on this point.

1. The urea in many analyses is increased.

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[1] That this is simply owing to drainage from the skin and lungs is evident by the ease with which the skin can be made to act by the hot-air bath; the urine is then diminished. Can the frequent pulmonary disease of diabetics be connected with the impairment of the normal water-excreting function of the pulmonary mucous membrane?

[2] Archiv des Vereins, Band iii, p. 29.

[3] Deutsche Klinik, 1853, Nos. 22, 23, 25, 26, 31, 39; and Vogel, in Canstatt's Jahresb., 1853. Report on Chronic Diseases.

[4] Traube, in Virchow's Archiv, vol. iv, p. 109. If a febrile disease comes on in the course of diabetes, the thirst lessens, and the urine, as well as the sugar, diminish in amount (Petters, Uhle, Thierfelder).

Mean amount in 24 hours.		Patients.		Excretion to weight of body in 24 hours.	Diet.	No. of days furnishing the mean amount.	Observer.
Grms.	Grains.	Sex.	Age.				
25·97	421	M.	9	1 lb. avoir. = 7 grains.	Meat.	35	Author.
29·42	454	F.	...	...	Mixed.	5	Ringer.
35·36	545	M.	41	1 lb. = 3·91 grains.	Mixed.	8	Rosenstein.[1]
34·94	539	M.	30	1 lb. avoir. = 5·23 grains.	Mixed.	12	Author.[2]
45·00	684	F.	16	...	Mixed—bread, milk, a little meat.	6	Heynsius.[3]
46·00	700	M.	35	1 lb. avoir. = 5·83 grains.	Mixed.	6	Rosenstein.[4]
52·00	808	...	...	...	...	...	Böcker.[5]
57·20	884	...	...	...	...	...	Christison.
58·54	904	M.	...	...	Meat.	...	Garrod.[6]
65·60	1013	...	...	...	...	...	Macgregor.
89·00	1374	M.	33	1 kilogramme = 1·5 grms.	Mixed, with excess of meat.	41	Thierfelder and Uhle.[7]
90·00	...	...	25	1 kilogramme = 1·6 grms.	Ditto.	14	"
94·00	1411	...	...	...	Mixed.	...	Mosler.[8]

The immense increase of the urea is best seen by a reference to the amount excreted by a pound or kilogramme of body-weight; it is then found that the amount may be double or even treble the healthy quantity. To what is this owing?

(*a*) To the animal diet? That this has a great effect is evident, but will it account for all cases? The patient of Heynsius was on mixed diet; so was my second case, who, moreover, at times, ate very little. Leubuscher[9] records a case in a girl who, on a mixed diet, passed an excess of urea. Neither the quality or quantity of the diet will, therefore, wholly account for this excess.

(*b*) To attendant phthisis and pyrexia? My patient was phthsical, but not febrile. The temperature in Leubuscher's case was invariably under the normal amount, and this patient was not phthisical. In fact, the temperature in diabetics is frequently under the standard.

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[1] Virchow's Archiv, Band xii, p. 414.

[2] The diet of this man was daily, 1 sole, 2 eggs, 4 pints of milk, ½ lb. of greens, 1 lb. of bread, and ½ lb. of mutton. But the meat was seldom entirely eaten.

[3] Hollandische Archiv, Band i, p. 246.

[4] Virchow's Archiv, Band xiii, p. 465.

[5] Deutsch Klinik, 1853, Nos. 33, 34, 35.

[6] Gulstonian Lectures, 1857; Brit. Med. Journ., April.

[7] Archiv für phys. Heilk., 1858, p. 32.

[8] Archiv für wiss. Heilk., Band iii, p. 30.

[9] Virchow's Archiv, Band xviii, p. 120.

(*c*) To the excessive thirst and the action of the water? As water-drinking in health does appear to increase the amount of urea, this may have some effect.

(*d*) To lessened egress of urea through the dry skin, or to lessened exit of nitrogen in some other way? On these points, we know nothing; but as the skin is so dry, it does not seem unlikely.

(*e*) To some peculiarity in diabetes, causing heightened metamorphosis,[1] such as might arise from excessive action of the oxygen on nitrogenous tissues?

As the sugar cannot be oxidized, one of the limitations to the action of oxygen on the tissues is removed (see p. 61), and in this way it is very likely that the unshielded nitrogenous tissues suffer. But we cannot at once adopt this explanation, on account of the fact now to be noticed.

2. The urea is stated by some writers to be normal, lessened, or even absent.

Prout[2] met with cases of lessened urea, and since his time other observers have stated the same fact. To some of these statements, however, exception may be taken. Herr Von Dursch's analyses[3] may be objected to on account of the method employed, and of the short space of time during which the analyses were carried on; still he affirms that in eighteen analyses he found the urea four times absolutely, and twice partially, absent. Gorup-Besanez[4] found no urea in one case (a woman of twenty, phthisical), though the patient was on meat diet; and Stokvis[5] also noticed the urea to be lessened, though not to be entirely absent. Heller[1] has made a similar statement; but as his analyses are merely per-centage accounts, they are of little worth.

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[1] Since these pages were written, Mr. Sydney Ringer has examined some cases of diabetes, in which the excretion of urea was much greater than could possibly be accounted for by the food.

A woman (Mrs. H.) was passing daily (mean of 9 days) about 10 grammes (154 grains) of sugar; and no less than 70·61 grammes (1090 grains) of urea. The diet was nitrogenous, but was only in moderate quantity.

In another woman (Mrs. G.), the average amount of sugar from 42 days' observation was about 50 grammes (772 grains) of sugar, and 49½ grammes (764 grains) of urea, in twenty-four hours. As the average weight was only 104 lbs., each pound of body-weight excreted in twenty-four hours 7 grains of urea, or nearly twice as much as usual. The diet of this woman was meat and eggs. At first there was a large carbuncle on the neck; her appetite was very bad, and then improved. As it improved, she gained weight (6 lbs.), and passed more urea; but even when the appetite was at its worst, she passed from 25 to 40 grammes of urea in twenty-four hours, which was certainly a great excess, considering the small amount of food entering the body. It might be in part accounted for by the pyrexia caused by the carbuncle.

[2] On Stomach and Renal Diseases, 5th edition, p. 25.

[3] Henle's Zeitschrift, 1854, Band iv, p. 20.

[4] Canstatt's Jahresb. for 1848; Valentin's Report, p. 134.

[5] Ibid., for 1856, Band iv, p. 353. It is the case of Gorup-Besanez which is described by L. Lehmann, in the Archiv für phys. Heilk., 1848, p. 205.

Now, certainly, the weight of evidence is great enough to cause us to pause before we reject the possibility of the urea being much lessened even on a meat diet; at the same time, the cases are not numerous, and the circumstances attending them are not well detailed.

There was great sweating in some of the cases (Gorup-Besanez), and, perhaps, some urea passed off by the skin. As Macgregor and Liermann[2] have found urea in the stools of diabetics, may there have been increased excretion by that channel in some of these cases?

The proportion of the urea to the sugar, when the excretion of twenty-four hours is taken, is very various; when, however, fasting hours only are considered, there appears to be a certain relation (Sydney Ringer), to which reference will again be made.

The effect of food upon the urea in diabetes is the same as in health. The urea increases in about the usual time after mixed and nitrogenous food, and, probably, is proportionate to this. Mr. Ringer has found the influence of food to disappear sometimes in eight, sometimes not till fifteen hours. Some experiments of Mr. Sydney Ringer's[3] had a very unexpected result. From seven series of trials on the same patient, it was found that the urea in fasting hours increased in amount when sugar of any kind—glucose, lactin, or cane-sugar—was given. This observation requires so many experiments, and such careful repetition of them, before it can be received, that I merely mention it at present as a subject for future inquiry.

3. The uric acid, like the urea, appears to be sometimes in larger, sometimes in smaller quantity than usual. Prout thought it increased in "favorable cases." In many cases I have found large precipitates of uric acid when the acid fermentation was going on.

Gorup-Besanez and Stokvis, in the cases in which the urea was deficient, found also an absence of uric acid. Von Dursch also found it absent in ten analyses, and in traces only in other ten. In Heller's analyses, it was generally absent or in traces.[4] Böcker noted only 0·18 grammes, or 2·77 grains, in twenty-four hours. Ranke,[5] in one case, found it not weighable; in another, it was in rather small amount.

In spite, however, of this concurrent testimony, the exact amount of uric acid in diabetes cannot be said to be yet determined; for, on account of the immense dilution, the analyses are liable to no little error. Yet that uric acid is not in unusual amount seems certain; whether it is lessened is more doubtful.

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[1] Archiv für path. Chem., 1853, p. 447.

[2] Archiv für Phys. Heilk., 1848, p. 208.

[3] As yet unpublished, but to appear in the Med.-Chir. Trans.

[4] Archiv für path. Chem., 1853, p. 446.

[5] Ausscheidung der Harnsaure, p. 35.

4. Hippuric acid.—Professor Lehmann found hippuric acid in large quantities in some cases;[1] and others have in some measures confirmed this.[2]

On the other hand, Bouchardat could not find it,[3] nor Stokvis either, with certainty. In the case already quoted from Gorup-Besanez it was also absent. Garrod[4] in no case "noticed an augmentation;" and the latest observer, Weissmann,[5] found it lessened in three cases, he believes from the meat diet.

The influence of the diet on which the patients were kept during those observations has not been well determined. Does it then occur after vegetable, but not after animal food? Heller found it, in one case, before strict animal diet was enforced, but not afterwards. Lehmann, on the other hand, discovered it for some days after exclusive flesh diet.[6] In the last edition (1859) of his Handbook, he says (p. 66), "In the urine of diabetics on a strict animal diet, the hippuric acid is not absent."

Benzoic acid forms hippuric acid in a diabetic system, as in other cases, when it is taken as a medicine. There is, therefore, no want of glycin.

5. The sulphuric acid varies. Often it is increased by the meat diet. Böcker found 4·19 grammes, or 64·69 grains, and Mosler, 5·4 grammes, or 83 grains, in twenty-four hours.

6. The phosphoric acid appears to be much less, or not at all, increased. It may be even much lessened, as appears from a case of Schultze.[7] Heller states, indeed, that the earthy phosphates are lessened. In a case lately examined by Neubauer,[8] the phosphate of lime was 2·4 grammes, and the phosphate of magnesia 1·14 grammes, in twenty-four hours, showing no decrease. Probably, the phosphoric acid is little altered.

7. The chloride of sodium varies much, according to the food

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[1] Phys. Chem., Band i, p. 203.

[2] Ambrosiani and Hunefield, quoted by Lehmann.
Duchek, loc. cit.
Wicke, Zeitsch. für rat. Med., Band vi, p. 311.
F. Simon, Scharlau.

[3] Valleix, Guide du Med. pract., t. iii, p. 549.

[4] Gulstonian Lectures for 1857; British Med. Journal.

[5] Henle's Zeitsch., 1858, Band ii, p. 339.

[6] Ludwig's Phys., 1st edit., Band ii, p. 263.

[7] Virchow's Archiv, Band vii, p. 480. The analysis appears, however, to have been only on one day.

[8] Liebig's Annalen, Band xcix, p. 206.

and to the degree of inactivity of the skin. Often, however, owing to abundant ingress and to lessened cutaneous egress,[1] it is in enormous amount. A few cases will illustrate this.

ClNa in 24 hours.		Observer.[2]
Grammes.	Grains.	
21·86	337	Böcker.
27·6	429	Thierfelder and Uhle.
29·0	447	Mosler.
29·75	459	Rosenstein.
32·85	507	„
36·8	568	Thierfelder and Uhle.
7·92	122	Author (in a boy of nine years).

In the case recorded by Rosenstein, the variations in the chloride of sodium were in inverse proportion to those of the sugar. Occasionally the ClNa is in small amount, probably from diet. In one instance, in which the urine was albuminous, Picard found it entirely absent. In this case there were, in twenty-four hours, 4·85 grammes of albumen, 32·64 grammes of urea, and 0·670 grammes of uric acid.[3]

8. Böcker found the ammonium and potash normal. The sodium, of course, is increased when the chloride of sodium is in large amount. The lime and magnesia are referred to under the head of "Phosphoric acid."

9. Judging merely from the colour, the pigment of diabetic urine would not seem to be in great amount; yet in Böcker's case the volatile salts and extractives were found to be enormously increased. In Mosler's case also, the pigment was augmented. Whether this is constant is not known. According to Heller, the normal pigment (urophœin) is always lessened, but the uroxanthin (the substance giving a violet-blue reaction with hydrochloric acid) is increased.[4] Schunck obtained more indigo-blue from diabetic urine than from any other. Stokvis has also noticed peculiar tints produced by nitric acid. I have sometimes seen this well marked, but in other cases it has been absent.

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[1] Rosenstein quotes a case (op. cit., p. 423) in which the ClNa in the sweat of a diabetic patient was "much diminished." In another case, Rosenstein kept a healthy man and a diabetic on the same diet; the first passed 23, the latter nearly 33 grammes of ClNa, in twenty-four hours, though the ingress is pronounced to have been equal. The activity of the skin was, therefore, widely different in the two cases.

[2] The references to the cases have been already given.

[3] Scherer's Report, in Canstatt's Jahresb., 1856, Band ii, p. 74.

[4] Archiv für path. Chem., 1853, p. 446.

10. The free acidity of diabetic urine is often not great at first; but its exact amount is difficult to determine, as the urine becomes more acid very rapidly after emission, before fermentation has commenced. The acid thus formed may be, apparently, either lactic,[1] butyric, acetic, formic, or propionic.[2] The existence of butyric acid was first discovered by Fonberg; lately, Neubauer[3] has stated that, during fermentation, only acetic acid is formed. Scherer,[4] however, has confirmed Fonberg's statement, that butyric acid may be produced.

On standing, diabetic urine begins soon to ferment, with the appearance of the acids above noticed, and of the yeast-plant. During the fermentation, the urea entirely decomposes. Uric acid, when present in any quantity, is at first precipitated by the free acid, then decomposed during the fermentation; sediments of oxalate of lime are extremely rare.[5] The acidity increases during the fermentation, partly from the production of the acids above mentioned, partly from that of carbonic acid.

Abnormal constituents.

Sugar.—The presence of a considerable quantity of sugar is the essential symptom of diabetes, though perhaps in health, and certainly in many diseases, some quantities of sugar are for a time present. Owing to the presence of the sugar, the diabetic urine has a sweet taste, and a specific gravity which ranges from 1030 to 1074 (Becquerel), but on an average, and tolerably constantly, is 1040.

The *kind* of sugar in diabetes has been hitherto grape-sugar. Many years ago, Thenard and Bouchardat thought they had found a peculiar tasteless sugar in diabetes; but they afterwards abandoned this notion, though perhaps they did really find inosite.[6]

In some cases of apparently true diabetes, the sugar is intermittent in its appearance (Bence Jones, in old persons;[7]

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[1] Lehmann, Hünefeld, Virchow's Archiv, Band vii, p. 400.

[2] Klinger, Annalen der Chemie u. Pharm., Band cvi, p. 18.

[3] Liebig's Annalen der Chem. und Pharm., Band xcix, p. 206.

[4] Canstatt's Jahresb., 1856, Report on phys. Chem., p. 186; and 1858, Report on path. Chem., p. 79. See also Ruge in Canstatt, 1860, Band i, p. 55. The presence and amount of butyric acid depend on the temperature. If the temperature be under 20° C. (70° Fah.), it is not formed.

[5] Beneke, zur phys. und path. des phosphors. und oxals. Kalkes. Gott., 1850.

[6] Bernard, Rees, and Pavy have all stated that the sugar produced by irritation of the base of the brain in animals, and liver sugar, are different from diabetic sugar in men, being much more easily decomposed. Schiff (Meissner's Report on Phys. in Henle's Zeit. for 1858, p. 382) has come to the conclusion that the liver sugar produced by *nervous irritation* is different from that produced by nervous *paralysis*. In his experiments, this last resembled the diabetic sugar of men, and decomposed with difficulty.

[7] Med.-Chir. Trans., vol. xxxvi, p. 401.

Warnecke and Girard, in young persons), without obvious cause. Usually, however, it is constantly present.

The *amount* of sugar varies greatly, amounting sometimes to 1 pound, or 2 pounds, or even 2½ pounds, in twenty-four hours. In a few months, patients will pass their own weight in sugar. In a few rare cases the amount is small, and remains so. The percentage amount may be as high as 15, or more.

The amount of sugar is influenced by the following circumstances:

(*a*) Saccharine and amylaceous food.—In every case of diabetes, the sugar in the urine is augmented by this kind of food. To this rule there appears to be no exception; the augmentation is soon perceptible (within two hours) after food, and continues for some hours (4—6) if the amount of starch has been considerable. It is not yet proved that all the starch taken by diabetics appears as sugar in the urine, and that no single particle of it is destroyed in the system; but this is probable. In some diabetic cases, *all* the urinary sugar is produced from the starchy food. Thus in two patients examined for more than two months by Mr. Graham, the quantity never exceeded the amount of starch, and almost all the starchy food was accounted for by the diabetic sugar.[1] In one of my patients this fact was most unequivocal; abstinence from starchy food completely freed the urine of sugar, while so thoroughly was the complete metamorphosis of starch arrested, that the smallest quantity taken as food presented itself as urine-sugar. In a case lately described by Moritz Traube[2] the same fact was noticed; the sugar was derived solely from the amylaceous food. A very interesting case of this sort is described by Bence Jones,[3] and another is noted by Rosenstein.[4] In an acute case of diabetes lately described by Mosler, and already referred to several times, the sugar entirely disappeared when the patient was on meat diet. Such cases as these are familiar to all practitioners, although they are not very common. Traube conjectures that this condition is the very earliest stage of diabetes; and certain it is, that, both in his case and mine, during the progress of the disease, the sugar began to be formed in other ways, and was no longer derived solely from the starch. Whether, however, at the outset of diabetes sugar is *only* thus formed cannot be held to be yet decided.[5] In such cases, complete fasting or abstinence only from saccharine and starch food for eight or twelve hours reduces the quantity of urine to the normal amount, and brings down the specific gravity to its usual figure. Sugar can then neither be detected in the urine or blood.[1]

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[1] Walshe's article on Adventitious Products, in Cyclopædia of Anatomy and Physiology, part xxx.

[2] Virchow's Archiv für path. Anat., vol. iv, p. 109.

[3] Med. Times and Gazette, Feb. 4, 1854.

[4] Virchow's Archiv, Band xii, p. 414.

[5] It would appear that in some cases the sugar may own no origin but starchy food for many years. Apparently, Mr. Camplin, who has kept his disease at bay for ten

(*b*) *Nitrogenous food.*—In the majority of cases,[2] the diabetic sugar is not derived only from starch; it is also produced by gluten or animal food. The most complete abstinence from starch then lessens, but does not entirely remove the sugar from the urine. The fact that nitrogenous food may give rise to sugar seems so certain, that I may be pardoned if I omit to adduce the full evidence. In some cases—perhaps in all—(Traube's and my own, for example) the formation of sugar from albuminous food is a more advanced stage of the condition in which sugar is formed only from starchy compounds. The dependence of the diabetic sugar on food is still quite manifest; its amount begins to increase soon after meals, and continues large for some hours, when it begins to fall; and if complete abstinence be adhered to, the sugar finally disappears altogether from the urine. The relative amount in any case of the sugar derived from the starch, or from nitrogenous food, varies greatly. In a case related by Schultze,[3] the amount of sugar in the urine when the patient was on mixed diet was one third more than could have been furnished by the starch food. The amount, however, is easily known by keeping the patient on a strict meat diet, to which starch is added from time to time, as an experiment. It then appears, that in some cases the sugar formed from nitrogenous food is small, in others large; and it may be that the amount of sugar from this source increases as the disease advances.[4]

years, as described in his most interesting paper in the Medico-Chir. Transactions (vol. xxxviii, p. 69), has suffered only from this form of this disease.

[1] In my patient, I made many analyses of the blood, to determine this point.

[2] In thirty cases recorded by Heller (Archiv für path. Chem., 1853, p. 443), only in one did the sugar disappear from the use of nitrogenous food. Even in this case it often appeared again.

[3] Virchow's Archiv für path. Anat., Band vii, p. 397.

[4] It is not my object to inquire in what part of the system the nitrogenous food is converted into sugar. It is, of course, in part, in the liver.

If it be true that at first the sugar is formed only from the starch, and only in a more advanced period from nitrogenous food, it is evident that two conditions affecting food are present in diabetes; the earliest and fundamental one, which continues to act throughout, is the complete arrest to the normal metamorphic changes of starch and sugar. At first, this affects only the sugar derived from starch food, then it affects the sugar formed from nitrogenous food. May not, as conjectured by Dursch, the cause of this arrest be some substance produced in the digestive canal, and absorbed with the sugar? Chemistry will sometime tell us what substances will thus prevent transformation.

The second condition is an abnormal production (in the liver?) of sugar from nitrogenous food, *i. e.*, an amount of production which is abnormal, combined with the arrest in the transformation of the sugar thus normally formed. Can diabetes ever begin at once at this point, or must it pass through the former stage?

From Griesinger's[1] accurate observations, it appears that a diabetic patient, kept on the most rigorous meat diet, passed a quantity of sugar corresponding to two fifths of the entire meat food, or to three fifths of the albuminate contained in the meat. In some cases the amount of sugar formed from albuminous food is less than this; in some cases it may possibly be more.

(*c*) Of the various kinds of food, milk furnishes much less sugar than other similar compounds (Bence Jones). Gum gives none (Graham), but then it may be not absorbed; for Lehmann and Busch[2] have shown how very little gum is taken up from the intestines. Alcohol is destroyed (?), as in health (Graham). Fermented liquors, such as bottled porter, do not increase the sugar so much as might have been anticipated (Bence Jones); the cause of this cannot be the alcohol, and carbonic acid, when in combination with alkalies, has not the same effect. The gelatin-yielding tissues give more sugar than washed fibrine (Bouchardat). Rennet lessens the sugar in some degree (Gray). Andral has stated[3] that *fasting or any change of food* will, for the time, lessen the amount of sugar. A woman who had fasted for some time, on account of gastro-intestinal disorder, lost the sugar altogether; and when she again took food, the sugar did not return for three days. A woman, passing 27 grammes of sugar daily, was placed on meat diet; the sugar sank to 10 grammes; then the diet remaining the same, it rose to 27 grammes. Here, plainly, was an increase of the sugar derived from meat; vegetables being then added, the sugar sank to 15 grammes, then rose to 54 grammes. Harley[4] has produced artificial diabetes for several days, by eating largely of asparagus.

Grape, milk, and cane sugar, taken by the mouth, always increase, and, probably, proportionably the quantity of urine-glucose. In a case of Heller's, after 2 pounds of syrup, the percentage amount of sugar had risen from 7 to 10. The absolute quantity is not given. Perhaps, much of this sugar is not absorbed,[5] if the amount given at once be very large.

—Dr. Bence Jones has made the ingenious suggestion in reference to the metamorphosis of starch, that in some cases the changes may pass one step beyond sugar, and produce "vegetable acid;' and he thinks a disease exists which is allied thus to diabetes, and is characterised by a great amount of acid (lactic?) in the system and in the urine. This very important subject has not been further worked out, to my knowledge (Animal Chemistry, 1850, p. 117). The chief transitional changes of starch enumerated by Bence Jones are starch sugar, vegetable acid, carbonic acid. The arrest is supposed to occur at the acid stage, instead of at the sugar stage.

[1] Archiv für phys. Heilk., 1859, p. 53.

[2] Virchow's Archiv, Band xiv, p. 173.

[3] Comptes Rendus, July, 1855.

[4] Brit. and For. Med.-Chir. Rev., 1857.

[5] In stating that glucose, lactin, and cane-sugar all increase the diabetic sugar, I do not imply any criticism on the treatment of diabetes by these substances, or by

(*d*) *Tissues* (*inanition*).—In some cases the diabetic sugar is not derived altogether from starchy or nitrogenous food. It appears during complete inanition, and must then be furnished by the tissues. At least, this would seem to be the explanation of the following facts:—Towards the end of Traube's case, already referred to, the greater part of the sugar came from the food; on fasting for some hours, the sugar gradually lessened, as the influence of food more and more disappeared. It was noticed, however, that after a certain length of time the sugar ceased to fall in amount; and after this, though no food was supplied, a constant quantity made its exit from the body. The explanation was, that some portion of the body itself furnished it, and Traube supposes that it was the liver. Traube determined the amount of sugar thus excreted without being derived directly from the food, and found it to be 2·9 grammes, or 44·7 grains, per hour (1072 grains in twenty-four hours). In two cases examined by Mr. Ringer (male and female), the amount during complete inanition was, in the first case, from 2·4 to 5·3 grammes, and in the second case, from 1 to 3·7 grammes per hour. The whole of this must have been furnished by some of the tissues.

Does this origin of the sugar occur only in the advanced cases, when rapid emaciation is going on; and is it an abnormal or unnatural production of sugar, or merely a further stage of the disease, which is the consequence of the want of power of destruction?[1]

Mr. Sydney Ringer has examined very carefully, in these two cases of diabetes, in order to determine especially the amount of urea and sugar furnished by the tissues of the body (inanition) and by nitrogenous food. I subjoin the tables he has permitted me to use, and which form only a part of a very elaborate investigation.

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saccharine vegetables. The utility of such treatment must be examined on other grounds.

[1] In one of my cases, in which a large amount of sugar was thus furnished by the tissues of the body (during inanition), I found the blood, after seventeen hours' fasting, to be still very rich in sugar. Now in healthy persons, after such a fast, the amount of sugar in the blood is small or indetectable. Therefore it could not have been destroyed in this case.

Male patient: hourly amount of sugar and urea during inanition.

Hours after food on the same day.	Urea per hour.	Sugar per hour.	Ratio of urea to sugar.
	Grammes.	Grammes.	
Ninth	2·582	4·881	1 : 1·89
Tenth and eleventh ...	2·415	4·772	1 : 1·97
Twelfth	2·127	5·350	1 : 2·51
Thirteenth	1·598	4·545	1 : 2·84
Fourteenth	2·202	5·025	1 : 2·28
Fifteenth	1·560	3·260	1 : 2·09
Mean	2·08	4·639	1 : 2·23
Hours on separate days.			
Thirteenth	1·909	4·825	1 : 2·5
"	1·680	3·997	1 : 2·3
Fourteenth	2·430	5·319	1 : 2·1
Fifteenth	1·428	2·453	1 : 1·7
Mean	1·861	4·148	1 : 2·24

Taking the mean of the two series, this man passed hourly, when fasting, 2 grammes of urea (= 48 in twenty-four hours) and 4·4 grammes of sugar (= 105½ grammes in twenty-four hours), which was derived from his tissues alone. This would seem to imply an enormous disintegration of tissues. The relation between the urea and the sugar is tolerably constant, viz., as 1 : 235.

The above series may be compared with the hourly excretion of urea and sugar after nitrogenous food in the same patient.

Hourly excretion after nitrogenous food (meat).

Hours after food.	Urea.	Sugar.	Ratio of urea to sugar.
	Grammes.	Grammes.	
First...	1·583	3·856	1 : 2·4
Third	1·972	3·604	1 : 1·8
Fourth	2·618	4·181	1 : 1·6
Fifth...	3·832	8·214	1 : 2·1
Sixth	2·970	5·851	1 : 1·9
Seventh	2·380	4·427	1 : 1·8
Eighth	2·042	3·437	1 : 1·6
Mean of the seven food hours	2·485	4·795	1 : 1·9

The urea is seen to rise slightly in the third hour after food, in a greater degree in the fourth, and to reach its maximum in the fifth hour; it then falls during the three next hours, and nearly reaches the inanition amount in the eighth hour. The sugar follows the same rule, and almost in an exact ratio. But it is observable, that in this series, as compared with inanition periods, the urea is in slight relative excess to the sugar, showing that the nitrogenous food raised the urea slightly more than the sugar; the inanition series being 1 : 2·235, the nitrogenous food series 1 : 1·9.

A second experiment gave the following results:

Hours after nitrogenous food.	Urea.	Sugar.	Ratio of urea to sugar.
	Grammes.	Grammes.	
First...	2·080	3·846	1 : 1·8
Second	3·048	7·937	1 : 2·6
Third	3·744	9·523	1 : 2·5
Fourth	3·450	8·522	1 : 2·4
Fifth...	3·510	7·283	1 : 2·0
Fourteenth (inanition) ...	2·034	3·945	1 : 1·9
Mean of the five food hours	2·977	6·842	1 : 2·2

The increase in the urea and sugar occurred in the second hour, and reached the maximum in the third; both urea and sugar fell slightly in the next hour, while, in the fifth hour the urea very slightly rose, the sugar continued to fall. The relation of the urea and sugar was here precisely the same as in the inanition hours.

That there is some close connection between the amounts of the urea and sugar in these experiments seems to me nearly certain.

When starchy food was given to this patient, the ratio between the urea and sugar was altogether destroyed; because, of course, the starch was converted into sugar, and the amount of sugar in the urine depended on its quantity. The twenty-four hours' urine, then, of a diabetic man, fed on common food, cannot be expected to show any relation between urea and sugar. Mr. Ringer has furnished me with a table, showing the urea and sugar excreted in twenty-four hours on mixed diet, by this man. The ratio varies between 1 to 3·9 and 1 to 20·4.

In the second case (a woman) examined by Mr. Ringer, the following was the result of the examination of four fasting hours:

Hours after food.	Urea per hour.	Sugar per hour.	Ratio of urea to sugar.
	Grammes.	Grammes.	
Ninth	0·697	1·281	1 : 1·8
Tenth	1·813	3·799	1 : 2·0
Fifteenth	0·727	1·631	1 : 2·2
Seventeenth...	0·456	1·041	1 : 2·2
Mean	0·923	1·938	1 : 2·1

It is noticeable here, that the urea in the fasting hours was smaller than in the former case; the mean amount was 0·923 gramme per hour (= 22 grammes in twenty-four hours); but as this woman was excessively thin, and had eaten very little before these experiments, the ureal excretion was really in excess. She was feeding on her tissues much too rapidly. It is very interesting to observe, that the ratio of the urea to the sugar, in the inanition hours, is almost the same as in the case of the man.

(*e*) *Water-drinking.*— If diabetic patients take even more water than their thirst demands, the amount of sugar appears to be increased.[1] The urea is also increased, in all probability. Exact experiments are, however, still wanting on this point, but it appears the action of large quantities of water are the same in the diabetic as in the healthy person. In some cases, however, diabetic patients drink so much that it is impossible to make them drink any more.

(*f*) *Abstinence from water.* —The quantity of sugar is certainly lessened by denying fluid; but it appears from Griesinger's and Ringer's experiments (which are perfectly accordant), that this is simply owing to accumulation of sugar in the body. When fluid is again given, an excessive elimination of sugar occurs. Patients become extremely depressed and ill from this plan, owing, probably, to the impregnation of the body with sugar.

(*g*) The period of the day appears to have little influence, except as connected with meals. Repose has been stated to lessen, and exercise to augment, the sugar; but the observations are not satisfactory. In very advanced cases, the sugar is sometimes most abundant during the night,[2] without evident cause.

(*h*) *Action of other eliminating organs.* — That sugar is found occasionally in the *sweat* is generally admitted, and

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[1] Griesinger, Archiv für phys. Heilk., 1859, p. 74.

[2] Stockvis and Von Dursch, quoted by Virchow, in Canstatt's Jahresb., 1856, Band iv, p. 352. Also Heynsius, quoted by Moos, in the Corr. Blatt des Vereins für wiss. Heilk., No. 36, 1858, p. 549.

Griesinger[1] has shown that the amount of urinary sugar may lessen when the sweat is profusely saccharine. In one case, the amount in the urine sank from 187 grammes to 100 and 85·7 grammes in twenty-four hours, under these circumstances. Fletcher[2] obtained, in forty-eight hours, 6½ grains of sugar from a piece of flannel, three inches square, placed in the axilla.[3] In the colliquative sweat of phthisis in diabetes, Gorup-Besanez found sugar;[4] and Heller[5] always discovered it in the sweat, as well as chloride of sodium, a little fat, and colouring-matter. On the other hand, in one of my patients, a boy without phthisis, who was made to perspire profusely by the hot-air bath, Ranke found no sugar.

Sugar may exist both in vomited matters and in the stools, and perhaps some quantity may pass off in this way, but I am unaware of any quantitative analyses.

(*i*) *Febrile conditions.*—It is a very curious fact that, during many specific and non-specific febrile diseases, diabetic sugar lessens greatly, or disappears for the time. Is there in fever, then, some check to the formation of sugar from starch or nitrogenous food, or is there merely retention? [6]

In a case noted by Stokvis, the sugar, after falling from 388 grammes daily to 7·99 grammes, during a "gastric fever," rose after the fever was over to 296 grammes, *while the amount of food was yet lessened.* This looks as if retention had something to do with it, yet retention will not entirely account for it.

(*j*) *Approach of death.*—For some days before death, the sugar may entirely disappear from the urine. The cause of this is not known.

(*k*) *Effect of treatment on the sugar.*—Every conceivable medicine has been given in diabetes, but exact quantitative determinations of the effect on sugar have been made in comparatively few cases. I shall refer merely to the experiments which seem to me most exact.

Abstinence from fluids, as already said, lessens the elimination of sugar (Piorry);[1] but the effect is temporary, and the plan of treatment cannot be persevered in.

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[1] Archiv für phys. Heilk., 1859, p. 30.

[2] Med. Times, 1847, p. 394.

[3] Griesinger (op. cit., p. 31) quotes cases from Driessen and Seminola, which would imply that a disease attended with all the symptoms of marasmus, produced by ordinary diabetes, may result from profuse saccharine sweats, with almost an entire freedom of the urine from sugar.

[4] Archiv für phys. Heilk., 1848, p. 205. Case recorded by L. Lehmann.

[5] Archiv für path. Chem., 1853, p. 454.

[6] In dogs, it has been stated by Bernard that pyrexia, artificially produced, arrests the formation of hepatic sugar. We may reasonably infer that the same condition occurs in diabetic persons who become febrile. The fact will, perhaps, prove to be that there is both lessening of the formation of sugar and lessened elimination. Might the lessened elimination be the result of the retention of water which occurs in pyrexia?

The mineral waters of Carlsbad did not lessen the sugar in M. Traube's case, though the urine became alkaline. Almost the entire quantity of water and the alkaline constituents passed with the urine, though more slowly than in health.

The Vichy waters (bicarbonate of soda) have been said to lessen the sugar (Durand-Fardel, Barthès). The experiments are, however, insufficient, though the action of the bicarbonate of soda, determined by Gunzler, supports them.

Beer (Bairisch) increases the sugar moderately; the chloride of sodium greatly, and lessens slightly the urea (Rosenstein).[2]

Wine (Bordeaux, with brandy and without brandy, Madeira) increases the amount of sugar,[3] slightly lessens the urea, slightly increases the chloride of sodium (Rosenstein).

Alcohol increases the sugar, but not the water (Gunzler).[4] Ott, from observations on the same patient, confirms this; and also does Leubuscher, who, in addition, found the urea lessened.[5]

Coffee lessens the sugar, but increases the urea and chloride of sodium (Rosenstein).

Rennet has been employed by Iversen,[6] after Gray's recommendation. The sugar and water at first decidedly lessened, but then increased again. Ott, in the patient above referred to, found an extremely slight lessening of sugar.

Warm baths, for the time, lessen the amount slightly.

Antimony, mercury, lead, cadmium (Heller), zinc, silver, copper, are indifferent.

Bicarbonate of soda lessens the sugar, the amount being about one fifth (Gunzler).[7] The observations of Mialhe, however, on the deficiency of alkaline salts in the blood, are refuted by Lehmann and Poggiale.[8]

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[1] Dr. Sloane, in a very able paper on the use of sugar in diabetes (British Med. Journal, May, 1858), has pointed out that in Piorry's diabetic cases, treated with sugar, the amount of fluid was limited, and he attributes the improvement to this cause alone. I do not find, however, that this solution will apply to William Budd's and Corfe's cases, which were treated with sugar and sweet vegetables (parsnips and turnips), without limitation of water.

[2] Virchow's Archiv, Band xiii, p. 479.

[3] This result, and the action of alcohol, call to mind Harley's important experiments on the artificial production of diabetes by the injection of alcohol and ether into the vena portæ.

[4] Virchow's Archiv, Band xii, p. 341. The experiments are very accurate and trustworthy.

[5] Ibid., Band xviii, p. 121.

[6] Archiv für wiss. Heilk., Band iii, p. 12.

[7] Op. cit. See also Griesinger, in Archiv für phys. Heilk., 1859, p. 56.

[8] Action des Alcalis sur le Sucre, Compt. Rendus, Fev., 1856.

Phosphate of soda, in my experiments, had no marked effect on the sugar.[1]

Permanganate of potash did not, in a short series of trials by me, lessen the quantity of sugar.

Lactate of iron has no influence on the sugar, urea, and chloride of sodium (Leubuscher).[2]

Benzoic acid and benzoate of ammonia have no influence (Leubuscher).

Tartaric acid increases the sugar; slightly increases the chloride of sodium; slightly lessens the urea (Rosenstein).

Tartrate of soda and potash is changed into carbonate in the diabetic system, though perhaps more slowly than in health.[3]

Pepsin increases the urea, chloride of sodium, and sugar (Leubuscher). Some years ago, I made experiments with pepsin, and found it increased the sugar.

In one of my patients, Dr. Ranke found that salicine was oxidized in the same way as in the healthy body.

Opium and morphia have been long supposed to lessen the sugar. I have examined the effect for a short time in two cases, and believe that the general statement is correct. Yet, sometimes opium seems indifferent. It often lessens the appetite, and hinders the taking of food, and its action may partly consist in this.

2. Inosite.—In a case of diabetes mellitus, in which the patient continually lost ground, and yet the quantity of sugar lessened, Dr. Vohl[4] discovered that inosite was present. It increased in quantity as the glucose lessened, and at last as much as 18 and 20 grammes of pure inosite were procured from the day's urine. The amount of urea was small.

3. Albumen.—The number of cases in which albumen is found in diabetic urine is uncertain.[5] Dr. Von Dursch noted

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[1] The following is the summary of my experiments on phosphate of soda and pepsin:

Boy, aged nine, meat diet and bran cakes during whole period—

	No. of days furnishing mean.	Mean amount of urine.	Mean amount of sugar in 24 hours.	Weight at end of experiment.
No medicine	19 days	73 fl. oz.	1945 grains	52 lbs.
Phosphate of soda ʒss. to ʒiss. daily	15 „	78 „	1806 „	57 „
Warm baths five times a week	33 „	56 „	1281 „	61 „
Pepsin, 30 grains daily .	3 „	53 „	1667 „	61 „
No medicine, warm baths .	5 „	49 „	1876 „	61½ „

[2] Virchow's Archiv, Band xviii, p. 121.

[3] Kletzinsky, Wien Med. Wochenschrift, 1858, No. 32.

[4] Archiv für phys. Heilk., 1858, Band ii, p. 410. Vohl conjectures that the formula of water-free inosite is not $C_{12}H_{12}O_{12}$, but $C_2H_2O_2$. One atom of grape-sugar would thus represent six atoms of inosite.

[5] Gibb records (Lancet, 1860) a very curious case of cancer of the liver, and of

it in eight out of twenty-eight cases, or in 28·5 per cent.; Garrod, in about 10 per cent. In eight analyses recorded by Heller, traces of albumen are recorded in three, or 37·5 per cent.

The amount of albumen is seldom above 0·2 per cent. (Heller). It was formerly supposed (Dupuytren and Thenard) that the occurrence of albumen was favorable. Rayer, in his great work, expressed his dissent from this opinion, and has lately,[1] from extended experience, reiterated his former statement, that instead of this being a favorable symptom, it indicates the supervention of Morbus Brightii. Still, it is certain that, after some cases of albuminous urine in diabetes, the kidneys are not obviously in any of the conditions included under the term "Bright's disease."

The albumen sometimes appears towards the end of cases fatal by tuberculosis, yet the occurrence is too inconstant to lead one to connect the two conditions with each other.

The passage of albuminuria into mellituria, as surmised to occur by Schonlein, is decidedly very uncommon.

4. Fat is seldom seen in diabetic urine. The fat of the body appears to be oxidized in diabetic patients, though sugar is not so. The oxidation of fat, of salicine, and of the tartrates and acetates, seems to prove certainly that the oxidation power in diabetes is normal. It is the sugar that cannot be oxidized; not want of oxygen, which is the point of failure.

5. Sulpho-cyanogen.—Dr. F. Schultze[2] discovered in one case of diabetes, that perchloride of iron gave a deep-red colour to the urine, like that produced by the sulpho-cyanides.[3] After treatment with chloroform, which lessened the amount of urine, but did not remove the sugar, this reaction ceased.

Hünefeldt has often noticed this.[4]

In four cases which have occurred to me since I read this observation, I found this reaction in one (a very severe case), in others (one very slight, two very severe) it was not present.

6. Benzoic and lactic acid.—It is very probable, that what was formerly taken for benzoic was merely hippuric acid. Lactic acid forms so rapidly after the urine has been passed that, in spite of Bouchardat's authority, its presence before the urine has been exposed to the air must be considered to be as yet unproved.

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other organs, in which one kidney was large (7¾ ounces), and the other small (3 ounces). The pelvis of each was dilated, and contained urine; that of the large kidney had a specific gravity of 1026, and contained sugar; that of the smaller had a specific gravity of 1015, and contained albumen.

[1] Gaz. Med. de Paris, 1851, No. 26.

[2] Virchow's Archiv, Band vii, p. 397.

[3] The saliva of this patient did not give this reaction.

[4] Virchow's Archiv, Band vii, p. 420.

7. Phosphoretted hydrogen is stated by Heller to occur sometimes.[1] The same observer has noted hydrosulphuret of ammonium.

8. Aceton.—Petters[2] obtained by distillation, from the urine of a patient dying soporose, aceton ($C_6H_6O_2$). The smell of the blood obtained from the lungs also indicated aceton. The narcosis is attributed to the aceton. Petters thinks it arises not immediately from the sugar, but from a destruction product of sugar. It does not seem clear, however, that the aceton was anything more than a product of the distillation.

SECTION II.

URINE CHARACTERISED BY THE SIMULTANEOUS PRESENCE OF FAT, ALBUMEN, FIBRINE, AND BLOOD—CHYLOUS OR CHYLO-SEROUS URINE—MILKY URINE.

Under the term chylo-serous urine several different states appear to have been included, and some of them may, perhaps, be connected with organic disease of the kidney (ectasis of the lymphatics); but as the point is uncertain, I have placed them here.

1. As a normal condition in many persons, the serum of the blood becomes milky after food, partly from finely divided fat, and partly, or sometimes solely, from a very finely divided albuminous substance.[3] After a few hours the serum again becomes clear. The urine passed during the milky stage is, itself, sometimes milky, and from exactly the same causes, viz., from a very finely divided albuminous substance (peptone?), or from a mixture of this and molecular fat. I have known this condition occur slightly in the most healthy persons, and I believe it is owing either to the kind of food or to some imperfection in digestion, which renders the serum even more loaded with molecular albumen than usual. Frank observed it after great fatigue. This condition is transient, and may be easily recognised by its dependence on food. The urine does not coagulate spontaneously, but a creamy deposit sometimes falls on standing. Under the microscope the white matter is amorphous.

2. In a second class of cases, during suckling, fat and sometimes albumen[4] appear in the urine, which is not spontaneously coagulable. Here some of the ingredients of the milk

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[1] Archiv für path. Chem., 1853, p. 445.

[2] Meissner's Report on Phys. for 1857; Henle's Zeitsch., Band iii, p. 310.

[3] Buchanan, of Glasgow.

[4] Dr. J. Pearce, Lancet, 1851, March, p. 327.

would appear to pass into the blood. The microscopic characters are the same as in the preceding variety. There is usually epithelium from the bladder or kidneys, molecular fat, and occasionally fat-globules.

3. In other cases the urine contains not only albumen, but fibrine and blood-discs, which may not be derived from the food (Bence Jones);[1] and with them fat may be mixed, which is derived from the food. In other cases, as in one mentioned by Rayer, the blood, fibrine, and albumen are all, probably, connected with food. The specific gravity is often great; Branwell has noticed it as high as 1036.[2] When there is much fibrine, the urine solidifies like blanc-mange, and is either white or red, according to the amount of blood. Sometimes there are two layers; the lower fibrinous, the upper fatty.[3]

This is a most obscure disease, and appears to be sometimes connected with some peculiar condition of the renal vessels, or with the renal lymphatics; at other times there is no appreciable disease (Prout, p. 115). Cases recorded by Rayer and Bence Jones prove that movement may augment the disease greatly, and rest lessen it. It appears to be a disease of this kind which has been recorded as endemic in the Mauritius, Bourbon, Brazil, &c., and which is also seen among the negroes in the West Indies[4] and in Cuba;[5] only the amount of blood is greater, and sometimes precedes the fibrine and fat. The fibrine not only coagulates after emission, but also sometimes in the bladder, and occasionally produces retention.

In many cases this disease does not seem dangerous to life.

The urine has otherwise not been perfectly analysed. Prout, in one case, noticed "abundance of urea" in the urine of inanition, but little in the food urine. Beale[6] has given the percentage amounts of two analyses in one case; in the first analysis there was albumen and fat, which amounted to 13·9 parts per 1000; in urine passed in the after part of the same day there was no trace of fat or of albumen. It is not stated whether the first specimen was passed before or after food, but I infer it was before breakfast. Exercise, anxiety, and late hours, increased the milky appearance in this patient; stimulants lessened it. The quantity of fat appears to be sometimes great, and hence the term diabetes chylosa, which was formerly applied to this disease. Rayer mentions a case in which the urea and salts were in small proportion; but the urea in other cases has seemed in good amount, and the excellent health which many persons have even with highly chylous urine proves that neither the course of metamorphosis, nor the process of elimination, can be much interfered with. Uric-acid crystals appear to be rather often met with in the sediment. Pus-cells are very seldom met with. Prout thought the albumen peculiar—to be in an "hydrated condition," and not coagulating on heat. It is not unlikely to be, sometimes at least, in the condition of peptone (Lehmann)—the albuminose of Mialhe, which is characterised by its great diffusive property (Funke).

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[1] Phil. Trans., 1850, p. 651.

[2] Edin. Med. Journ., 1858, p. 714.

[3] Priestley, Edin. Med. Journ., 1856, p. 945.

[4] The best account of this disease is in Rayer, Mal. des Reins, tome iii, p. 373. For a late account, see Gubler, Hæmaturie de l'Ile de France, Gazette Méd. de Paris, 1858, No. 41. Gubler calls the disease "diabetes lymphaticus," and believes it to be produced by varicosity of the renal lymphatics. See also Prout, 5th edition p. 112, and Willis on Urinary Diseases.

[5] Metcalf, New York Journal of Med., 1856, Sept.

[6] Archives of Med., vol. i, p. 10.

It has been supposed that urine of this kind contained casein; but, on account of the great difficulty of separating albumen from casein, the analyses are not satisfactory, and the presence of casein must be held to be still uncertain.

Iron, cantharides (Rayer), and gallic acid (Bence Jones) are the remedies which have proved most useful. Prout mentions a case in which the chylous disposition of the urine disappeared during ptyalism, but afterwards returned.

SECTION III.

URINE CHARACTERISED BY THE PRESENCE OF CYSTINE.[1]

The occurrence in the urine of a substance containing nearly 27 per cent. of sulphur has naturally attracted much attention since the time when cystine was first discovered in a calculus by Wollaston in 1810, still very little is yet known on the subject.

Cystine is either dissolved in the urine, or it precipitates (either in an amorphous form, or as six-sided plates) in the bladder, or after emission.

The characters of the urine are a pale greenish-yellow colour, feeble acidity, and often a peculiar sweet-briar odour, which sometimes takes on a smell like sulphuretted hydrogen (Prout, Willis, and Golding Bird). As a rule, the sediments which co-exist (if any do) with the cystine are the ammoniaco-magnesian phosphates, which are thrown down from the feebly acid or neutral urine. Oxalate of lime is sometimes seen, but the urates are very uncommon. Mucus and epithelium are very usual.

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[1] For the history of the discovery of cystine, see Prout, Stom. and Renal Dis., 5th edition, p. 230.

The quantity of cystine excreted in twenty-four hours has been perfectly determined only by Tuel;[1] it amounted to 1·4 grammes, or 21·6 grains (in a woman aged thirty years). In an analysis of Prout, its per-centage amount was 3·4.

The other constituents of the urine have been determined by Bird, Tuel, and others. In a fluid ounce of urine Dr. Bird found—

	Grains.
Uric acid . . .	0·2
Urea	3·7
Cystine and extractives . .	8·1
Earthy phosphates . . .	0·2
Sol. salts . . .	2·8
	15·0

We are not informed what amount of urine was passed in twenty-four hours, but this urine must have been very dilute, or the secretion of urea must have been very small.

Tuel, who has lately found cystine in the morning urine of two sisters (twenty-eight and thirty years of age, who appear to have had some hereditary disposition to calculi, and who were chlorotic), noticed the following excretion,

In twenty-four hours, in grammes:

	Solids.	Urea.	Uric acid.	ClNa.	Cystine.
First sister, 30 years...	45·52	16·7	0·25	13·33	1·4
Second sister, 28 years	...	14 to 19	0·09 to 0·24	9·4 to 11·9	...

There was no albumen or sugar. Crystals of ammoniaco-magnesian phosphate, and much mucus, were mixed with the crystals of cystine.

The urea was evidently in small amount,[2] and the uric acid was perhaps rather diminished; unfortunately, Tuel did not determine the amount of the SO_3. In a case in which the per-centage amounts of the urine were determined by Dr. Beale,[3] the relative (and probably the absolute) amount of sulphuric acid was large (5·35 and 3·74 per cent. of the dried solids).

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[1] Beobachtungen über Cystin-Bildung; Liebig's Annalen, Band xcvi, p. 247; and Canstatt's Jahresb., Scherer's Report on Pathol. Chem., p. 74.

[2] Unless, as Scherer remarks, some was lost in the process; for the urine was evaporated to dryness, and the urea taken up with alcohol.

[3] Archives of Med., vol. i, p. 134.

Dr. Pletzer,[1] in the same cases, examined by Tuel, found the crystals of cystine smallest when the urine was acid, largest when it was alkaline. The amount of cystine was much increased by the use of fish and legumes. Organic acids lessened the amount.

In some cases (Stromeyer, Willis, and Venables) the urine has been especially deficient in uric acid; and, although Tuel's and Bird's analyses show that uric acid may be present in almost normal amount, it seems clear that there is sometimes an absence, and frequently a small amount, of uric acid. This agrees with the well-known fact, that calculi of cystine are generally free from urates or uric acid, or, if the two calculi are combined, one is merely a nucleus for the other, and the layers do not alternate.

Albumen and fat may be present in cystine urine, but are not essential.

The cause of the appearance of cystine is not known. It is singular how often it has occurred in several members of the same family (Shearman, Bird, Prout, Tuel), as if either there were a peculiar metamorphosis special to the family, or as if there was some peculiarity of food. It has been also supposed that there is an hereditary disposition to it.[2]

As already mentioned, Shearman has noticed it in the urine of chlorosis several times, and it has been supposed to be connected with scrofula, but of this there appears to be no sound evidence. Its connection with chlorosis is a point well worthy of careful investigation.

As the liver normally secretes compounds rich in sulphur,[3] it has been surmised that there is some imperfection or perversion of its action; but at present this is only guess-work. Nor is there any good evidence of deficient oxidation.

The symptoms connected with the appearance of cystine are very various and ill-defined. Debility, occasional pain in the back, and unhealthy, pallid appearance of the skin, are those

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[1] Archiv des Vereins, Band iii, p. 162.

[2] Prout held this opinion strongly. Dr. Golding Bird refers to an instance "in which it can be traced with tolerable certainty through three generations." I am not acquainted with the evidence on this point.

[3] Taurine and cystine have a close similarity of composition:

	Cystine		Taurine.	
Carbon . .	6 atoms	30·000 per cent.	4 atoms	19·20 per cent.
Hydrogen.	6 „	5·000 „	7 „	5·60 „
Nitrogen .	1 „	11·666 „	1 „	11·20 „
Oxygen . .	4 „	26·667 „	6 „	38·40 „
Sulphur. .	2 „	26·667 „	2 „	25·60 „

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most usually mentioned. The treatment is unknown. Prout thought nitro-hydrochloric acid useful, but Golding Bird does not confirm this.

SECTION IV.

URINE CHARACTERISED BY GREAT EXCESS OF WATER.

Diuresis,[1] *or Diabetes Insipidus.*[2]

There are three varieties of diuresis, not caused by medicine.

1. When it is associated with excessive thirst (polydipsia), and great quantities of fluid are drunk.
2. When it is connected with insufficient action of the skin and lungs.
3. When it arises during the removal of dropsical effusions, or after the retention of water in febrile diseases, or from other morbid conditions unconnected with thirst or deficient elimination from the skin.

1*st variety: Diabetes Insipidus with excessive thirst.*

A great number of the cases on record are in persons who have suffered from polydipsia, and extraordinary quantities of fluid are said to have been drunk.[3] A quantity of very pale urine, with very low specific gravity (1001—1006), is passed. I have found more urine passed during the day than night, simply, no doubt, because thirst is always indulged during the day.

It would appear, however, that the amount of water drunk, and urine passed, is not always proportional, or rather, that a person labouring under diabetes insipidus passes urine more rapidly than a healthy man after the same quantity of drink. Thus, in a case noted by Neuffer,[4] the following proportion was given—

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[1] The word Diuresis is perhaps the best that can be used, though the old term Diabetes Insipidus is not a bad one. It is much better than Polyuria. The term Hydruria is manifestly incorrect, since the water is not always increased alone.

[2] By this term is meant the passage of an unusual quantity of urine which does not contain sugar.

[3] Willis gives an extremely good summary of these cases.

[4] Ueber Diabetes Insipidus, Inaug. Diss., Tubinger, 1856. The patient died. Both kidneys were small, weighing each three ounces six drachms; not granular to the naked eye, but on microscopic examination the tubes were greatly widened; the epithelium was fatty or absent.

	Healthy man.	Diabetes insipidus.
In six hours, first experiment—		
Fluid drunk	1600 c.c.	1600 c.c.
Urine passed	1550 „	2250 „
In six hours, second experiment—		
Fluid drunk	1200 „	1200 „
Urine passed	990 „	2000 „

It was inferred that in the diabetes case there was some peculiar condition of the nervous system, which, by an effect on the contractility of the kidney vessels, allowed water to pass more rapidly through them. This conjecture is supported by Bernard's experiment, in which great diuresis is produced by operation on the sympathetic in the neck, in dogs and rabbits.

In some cases it has appeared as if more water was passed than had been taken as drink. In one of my patients, in eleven days 5396 fluid ounces were drunk, and 6048 ounces of urine were passed: 652 ounces in eleven days were then either supplied by the fluid food, or at the rate of 60 ounces a day, which is too high, or there must have been slight errors in measurement, which is very probable. But this case would imply that, as in diabetes mellitus, all, or almost all, the fluid taken as drink passes out by the kidneys, and scarcely any by the skin, lungs, or bowels.

In such instances it might be supposed that the effect on the urinary constituents would be similar to that produced when large quantities of water are drunk for experiment. This is not, however, always, or even frequently, the case; and it is probable that internal conditions, connected with the nervous state which produces the diuresis and the excessive thirst, modify in certain instances, at any rate, the usual effect of excessive water-drinking.

Henry[1] records a case in a woman aged thirty-four; she passed in twenty-four hours—

Water	14700 c.c.
Urea	6·550 grammes.
Salts	14·980 „
Uric acid	none.
Hippuric acid . . .	none.

The urea was lessened; the salts were relatively large; no uric acid was detected.

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[1] Archiv. Gén. de Médecine, 1848, 4 Serie, Tome xvii, p. 69.

Poggiale[1] analysed the urine of a man aged twenty-five, who was tormented with insatiable thirst. In twenty-four hours there were excreted—

Water	17391	c.c.
Urea	11·204	grammes.
Uric acid	0·624	„
Lactic acid Lactate of ammonia Ammoniacal salts Pigment and extractives	9·465	„
Sulphate of soda and potash	4·825	„
Phosphate of soda	0·234	„
Chloride of sodium	6·521	„
Phosphate of lime and magnesia	0·951	„
Silicic acid	0·036	„

The urea must be considered to be small in amount; the rest of the ingredients nearly normal, with the exception of the phosphate of soda, which was almost absent. This appears to be the most remarkable point in the analysis.

In a case of polydipsia hysterica, recorded by Alfred Vogel,[2] a considerable quantity of water (12 to 14 pints) was taken daily. Five analyses were made; four during the height of the disease, and one near its close.

	Quantity in 24 hours.	Specific gravity.	Urea.	ClNa.
			Grammes.	Grammes.
Mean of the four analyses at height	5400 c.c. (174 ozs.)	1001	11·28	9·64
Analyses at convalescence	2600 c.c. (83 ozs.)	1004	20·8	6·5

In this case there was an absolute and considerable diminution of the urea during the period of great thirst and diuresis, while subsequently, when the disease was passing off, the urea regained its normal amount. Certainly, then, in all these cases there could have been not only no increase of tissue metamorphosis, but there was a most decided decrease; the water taken in such large quantities must either have diminished tissue-change, or there was some underlying condition which had for simultaneous effects lessened disintegration and thirst.

In a case noted by Professor J. Vogel,[3] a man of Herculean frame, who suffered from rheumatism of the muscles of the neck, passed daily 2983 c.c. (96 ounces) of specific gravity 1005—1012. The calculated amount of solids was 42 grammes (648 grains) daily; they were therefore in lessened quantity.

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[1] Gazette Médicale de Paris, 1854, p. 503.

[2] Zeitsch. für rat. Med., Band iv, p. 362.

[3] Neubauer's Anleitung, 2d edition, p. 231.

In Eade's case[1] the urinary solids were presumed to be somewhat lessened, though, as only per-centage determinations are given, this is not certain.

The term "anazoturia" was employed by Willis to express the deficiency in the excretion of urea which occurs in this variety. The amounts of the other ingredients—the uric, sulphuric, and phosphoric acids—have been determined only in the cases of Henry and Poggiale.

The explanation of this class, of cases in which there is increase of urinary water (hydruria), combined with great drinking (polydipsia), and in which the urea is in small amount (anazoturia), is at present impossible. There is probably some peculiar nervous state favouring diuresis, but impeding metamorphosis, allied to the hysteric and hypochondriac conditions.[2] The facts seem certainly to favour the opinion that the primary lesion is in the nervous system, acting on the kidney, and draining the body of water.

In two cases noted by Baron,[3] the amount of urine was greatly augmented by starchy food.

According to Becquerel, there is thirst in some cases, and the water of the urine is greatly increased by the fluid drunk; but the absolute amount of solids excreted in the twenty-four hours remains the same, or "nearly so," as in health.[4] If this observation be correct, a second form of this variety of diabetes insipidus is given, in which the water merely passes off, without affecting metamorphosis in any way, either by lessening or increasing it. Future observations must decide if such a disease exists; to me it appears very doubtful.

In a third class of cases the polydipsia is said to be attended, not only by hydruria, but by an increase in some of the solids of the urine.[5] Thus, in one of my observations, a man passed, on an average of fourteen days—

Quantity of urine.	Specific gravity.	Urea.	ClNa.
Ounces. 104	1007·5	Grains. 545	Grains. 279

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[1] Beale's Archives, No. 5.

[2] A case is recorded by Montard Martin (Archives Gén. de Méd., Mars, 1860, p. 359), in which temporary polydipsia followed a blow on the head. Great muscular exertion, mental anxiety, and even the drinking of large quantities of cold water, have induced more or less long-continued diuresis (Lacombe).

[3] Gaz. Méd., 1856, No. 43.

[4] Traité de Chimie Pathol., 1854, p. 352.

[5] Both Prout and Dr. Bostock mention cases of this kind.

In this case there was slight increase in the urea, and great increase in the chloride of sodium. The metamorphosis of tissue was, however, remarkably irregular; that is to say, the variations in the amount of the urea and the chloride of sodium from day to day were very great, while the variations in the water, though considerable, were less so.

A case is quoted by Dr. Day,[1] from Dr. Golding Bird, in which the urea was not increased, but the uric acid and the fixed salts (no doubt, the chloride of sodium chiefly) were enormously augmented. The quantities were as follows:

Quantity.	Urea.	Uric acid.	Fixed salts.
Ounces. 138	Grains. 376	Grains. 21	Grains. 462

The amount of uric acid is most unusual, and almost incredible. It was as high as in almost any inflammatory disease.

A case is recorded by Prof. Vogel,[2] in which not only the urea and chloride of sodium, but the sulphuric and phosphoric acids were increased. A woman, aged thirty-six, with hysteria, passed the following amounts in twenty-four hours:

Quantity.	Urea.	Ch.	SO_3.	PO_5.
Ounces. 96—129	Grains. 617—756	Grains. 308—463	Grains. 47—77	Grains. 77—139

The free acidity and the pigment were, however, much lessened. In this case polydipsia is not mentioned, but as Vogel remarks that he has seen very similar cases from immoderate water-drinking, or from too long or ill-advised hydropathic treatment, it may be concluded that this woman drank a large quantity of water.

Thus, in complete contrast to the former series of cases, we see that all the chief ingredients may be increased, except, perhaps, the pigment, the alterations in which have not yet been made out. Only it is to be remarked, that in none of these cases was the amount of urine so excessive as in the first series.

Is now the increased elimination dependent on the water-drinking, or not? In other words, what is the relation, in the third form of this first variety, of these two facts to each other—increased ingress of water, and increased egress of urinary water and solids? Which is primary, and which secondary?

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[1] Simon's Chemistry of Man, Syd. Soc. edit., 2d vol., p. 306.

[2] Neubauer's Anleitung, 2d edit., p. 280.

It is evident that, if the thirst be considered to be secondary, two explanations may be given of the increased excretion of the urinary solids; either for some time there must have been delayed metamorphosis or retention of the normal ingredients, which is at last succeeded by a copious elimination; or there is heightened metamorphosis, and elimination of solids and of water, leading to thirst. In favour of the first opinion, we have the fact that the chloride of sodium is sometimes excreted in enormous quantities, which shows that, as far as this ingredient is concerned, there must have been previous retention. The evidence is not clear for the urea, for at present there are no reasons to think that symptoms of uræmia in any degree precede an attack of diabetes insipidus of this sort, and no analyses before the polydipsia came on have been made. Still, as the early stages of those cases have not been studied, it is not safe to exclude the possibility of such a condition.

In favour of the second opinion, viz. that there is an augmented metamorphosis leading to thirst, we have the fact of the organic constituents being increased, without any good evidence of previous retention.

There is also sometimes rapid loss of flesh, which is much more easily explained by the hypothesis of an increased tissue change than in any other way. On the other hand, there is none of the febrile action which ordinarily attends increased tissue metamorphosis. Becquerel and others have adopted unreservedly the opinion, that there is a disease characterised by this rapid disintegration and increased urinary solids and water, without other obvious symptoms, except the attendant emaciation. To such an affection Becquerel would restrict the term "polyuria," and would regard the thirst (polydipsia) as merely a consequence. Willis's term, "azoturia," only expresses the fact of the urea being increased, and is therefore less applicable than polyuria.

May not, however, the polyuria be secondary to the thirst? for we know that great water drinking does cause rapid disintegration. Or, to account for the great amount of chloride of sodium, may we not suppose that there is retention of this ingredient, but that the water-drinking induces the increase of urea and of SO_3, when this occurs? Prof. Vogel remarks, as already said, that he has seen exactly the same phenomena produced by the improper use of the water-cure; so that we are certain that the assumed cause would be adequate to the effect. But then what is the cause of the thirst? Some condition of the alimentary mucous membrane, or some special affection of the nervous system? But, if this be the case, how are we to account for the class of cases in which there is decided lessening in the amount of urea?

2d variety; Diabetes Insipidus from lessened exit of water by other channels.

2. In the second variety of diabetes insipidus the amount of urine is increased, not in consequence of more fluid being drunk, but in consequence of diminished exit of water from the skin, and perhaps from the lungs.

The effect of a destroyed balance between the skin and kidneys is so well known that, as far as the water is concerned, it is not necessary to bring forward any examples. As to the solids, scarcely any observations have yet been made to show the effect on them of impeded cutaneous excretion. It might be supposed that the solid excretions of the skin would, like the water, pass off in some form by the kidneys; but at present this has not been satisfactorily proved and in some cases certainly the urinary solids would seem to be lessened rather than increased. Thus, Professor Vogel mentions a case[1] in which, after exposure to cold which checked cutaneous transpiration, and which had induced rheumatic pains in the neck and shoulders, the urine was increased to 3000 and 3300 c.c. daily (96 and 106 ounces). The pigment and the free acidity were in normal amount; but the urea, chlorine, sulphuric and phosphoric acids were all below the healthy average.

That deficient excretion of pulmonary aqueous fluid will cause increase of urinary water has not yet been demonstrated; but that such occurrence may sometimes take place will be considered possible. I have noticed in some chronic cases of great pulmonary emphysema, without heart disease or dropsy, a large excretion of urinary water, without polydipsia or evident lessening of the cutaneous excretion. The difficulty is, however, to eliminate from the problem the share which the skin takes in the result. There are no easy means at present of assigning, with sufficient accuracy, the relative proportions of the pulmonary and cutaneous excretion of water.

Whether the arrest of the intestinal elimination of water (which is inconsiderable in health) will increase the urinary flow, is not yet known; usually, when the fæces are very dry, there is a general febrile condition which reduces the amount of urine.

3d variety; Diabetes Insipidus from absorption of water.

3. The third variety of diabetes insipidus is that in which it occurs during the absorption of dropsical fluids, and after other diseased conditions which have been attended by retention of

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[1] Neubauer's Anleitung, 2d edit., p. 280.

water in the system. During the diuresis of dropsy, there is often thirst, and the amount of urine is augmented also by this cause.

(*a*) Diuresis during dropsy is most common when the disease is anasarca; it may occur, however, in cases of uncomplicated ascites, dependent on contracted liver;[1] hydrothorax so seldom occurs alone, that it is impossible to say how often diuresis is present.

Diuresis during anasarca or ascites presents the same phenomena, whatever be the cause of the dropsy. From some reason, which is often inexplicable, and which can only occasionally be referred to the action of diuretic medicines, the dropsical fluids begin to pass into the blood, and then to find an exit by the kidney; or the kidneys, long inactive, begin to excrete water; and the blood, losing water by this action, gets into a state which favours diffusion from the anasarcous areolar tissue.

(*b*) The occurrence of diuresis is, so to speak, the normal course of cure in acute Morbus Brightii. The enormous congestion of the kidney, which exists during the height of this disease, lessens, the skin begins again to act, and no doubt from this restoration of the normal balance of elimination the dropsical fluid rapidly disappears. The amount of urine reaches 100, 140, 180, and even 200 ounces in twenty-four hours; the specific gravity is from 1006 to 1010; the albumen sometimes entirely disappears; the chloride of sodium is frequently in large excess (15 to 26 grammes); and the urea is sometimes, though not always, increased. The pigment and extractives, the sulphuric and phosphoric acids, were not increased in one of my cases; the amount of the uric acid is uncertain.

(*c*) In chronic kidney disease, the rapid disappearance of dropsy from diuresis is less common; but the phenomena are precisely the same, except that the albumen does not disappear. Thus Alfred Vogel[2] found in a woman the following excretion during two days:

Water.		Specific gravity.	Urea.		ClNa.	
c.c.	Ounces.		Grammes.	Grains.	Grammes.	Grains.
3700	119	1009	25·9	401	21·83	337
3000	96	1012	36·0	556	21·00	324

Brattler gives a very similar case. The anasarca was rapidly disappearing.

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[1] Vogel, in Archiv des Vereins, Band i, p. 119, relates a case of this kind. It is unusual.

[2] Zeitschrift für rat. Med., Band iv, N. F., p. 362.

Water.		Urea.		ClNa.	
c.c.	Ounces.	Grammes.	Grains.	Grammes.	Grains.
1810	63	19·17	295	6·38	98
3054	109	34·52	533	12·35	190
4392	153	42·13	650	22·27	343
4825	169	45·60	703	21·58	333
2000	70	24·3	375	13·5	208
Dropsy gone.					

The chloride of sodium, and, in the second observation, the urea,[1] were greatly augmented.[2]

In another case of the same kind, A. Vogel found the chloride of sodium increased by 2 grammes in each twenty-four hours, but the urea was not increased.

(*d*) In a case of cardiac dropsy, in which the diuresis was caused by digitalis, the same facts were observed by Prof. J. Vogel.

	Water.		Specific gravity.	Urea.		ClNa.	
	c.c.	Ozs.		Grms.	Grains.	Grms.	Grains.
Before digitalis ...	715	23	1022·5	27·17	419	10·64	164
After " ...	1450	46	1019·5	48·9	755	19·8	305

In another man in whom the urine had averaged 1000 c.c. daily, it was increased by digitalis to 3225 c.c., and the urea amounted to 45·1 grammes, or 696 grains.

(*e*) In splenic dropsy the same facts occur (J. Vogel). A man, with splenic tumour and great œdema of the feet, commenced rubbing in juniper ointment. Either from this or from some unknown cause, he commenced to pass a large amount of urine, which contained an immense excess of urea and chloride of sodium. Thus:

	Water.		Specific gravity.	Urea.		ClNa.	
	c.c.	Ozs.		Grms.	Grains.	Grms.	Grains.
Mean of nine analyses during diuresis ...	3555	114	1009	40·31	622	23·47	362
One analysis after diuresis	1100	35	1011	22·00	339	5·5	85

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[1] A. Vogel concludes that the urea was not greater than it should have been, but it was much over the average of healthy men.

[2] In this patient the dropsy subsequently returned, and she died with uræmia; the urea fell to 9·4, and the chloride of sodium to 6·33 grammes, in each twenty-four hours.

The increase in the urea might, of course, in the renal dropsies, be ascribed entirely to the excretion of that portion of the urea which, as Christison pointed out, is contained in the anasarcous fluid. But when this increase is found to occur in all dropsies, cardiac and splenic, as well as renal, the excess of urea may reasonably be referred, not only to excretion of urea which has been retained, but also to metamorphosis of the albuminates of the dropsical fluids. The large amount of chloride of sodium is doubtless attributable to the reabsorption of the fluid, which always contains a considerable proportion of chloride of sodium.

Diuresis, independent of thirst or lessened elimination from the skin or lungs, occurs in many diseases without dropsy. Thus, in almost all inflammatory and febrile diseases, in which there is no very great sweating or diarrhœa, the amount of urine is abnormally great during convalescence. It is possible that the water is retained in these cases, probably in the organs, especially the spleen, liver, and lungs. The amount of diuresis is not generally very considerable or long continued; the solids are in variable proportion, according as there has or has not been free excretion during the former period.

In certain cases of diuresis, two or more of these varieties are sometimes combined; there is at once greater thirst, lessened cutaneous excretion, and, in all probability, elimination of retained water. Beneke[1] has minutely investigated a most interesting case of this kind. A man who had had ague, whose spleen was much enlarged, and whose urine contained a little albumen, but who had no dropsy, passed for a long time a large quantity of urine; the mean of twenty-four days was as follows:

		Grammes.	
Daily ingesta—			
	Fluid . .	3049	
	Solid . .	1856	
			4905 grammes.
Daily egesta—			
	Kidneys .	2541	
	Intestines .	349	
	Lungs and skin	1884	
			4774 „
Daily increase in weight . .			131 „

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[1] Archiv des Vereins für wiss. Heilk., Band ii, p. 52.

The mean composition of the urine was—

Urea	41·286	grammes.
Albumen	2·112	„
Uric acid[1]	0·315	„
SO_3	2·280	„
PO_5	4·640	„
ClNa	17·690	„
Free acidity reckoned as oxalic acid	2·624	„

The mean results in this case were then an increase of all the excretions, with a marked excess of urea. But during the course of the disease the variations were great; the excretions of the skin and lungs were clearly antagonistic to the urine. At the commencement of the case when the urine was least (1790 grammes), the insensible perspiration was greatest (3020 grammes); then gradually the urine augmented, and reached 4104 grammes, while the insensible perspiration fell to the remarkable minimum of 407 grammes, or much less than half its normal amount. The influence of lessened transpiration was therefore certain, and that of the fluid drunk is of course evident. That this was also previous retention of urea and chloride of sodium, is evident from the large quantity of each which was poured out.

In no variety of diabetes insipidus is any unusual extractive or saccharine matter, or dextrin, found. The statements of Thenard and Bouchardat, that "tasteless sugar" is present, have not been confirmed; and Bouchardat, indeed, has given up his original opinion on this point. Albumen is occasionally found, but is not common; and its presence is, so to speak, accidental.

SECTION V.

URINE CHARACTERISED BY GREAT EXCESS OF UREA

(THE WATER AND OTHER URINARY INGREDIENTS NOT BEING INCREASED).

Dr. Prout[2] supposed that there was a disease characterised by the formation of a large quantity of urea, although the water and the other constituents of the urine were unaltered in quantity. Subsequently, Willis particularly described this affection under the name of azoturia.[1]

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[1] Mean of seven days. Often there was no uric acid in the urine; on other days there were traces.

[2] For Prout's last opinions, see the 5th edition of his great work, 1848, p. 94, et seq.

The description given by Prout proves that he was not speaking of a mere relative excess of urea, in consequence of deficient water. Of the occurrence of this condition he was quite aware, and distinguished it carefully from the absolute ureal excess which he appears to have demonstrated by special analyses. Unfortunately, Dr. Prout was not in the habit of communicating his observations in detail, and the opinion rests, therefore, merely on the authority which is to be attached to his dictum. Those, however, who, in studying this subject, have been led to appreciate Dr. Prout's great care and accuracy, will not underrate the authority of any opinion of his, and will be inclined to believe that, if Dr. Prout asserted the occurrence of a special disease characterised by an excessive excretion of urea, such a disease must really exist.

The testimony of Dr. Willis, also, is very material on this point.

Dr. Prout states that the affection is rare, and, in specifying the causes, he enumerates dyspepsia from inattention to diet, intemperance, mental anxiety, sexual excesses, and mercurial irritation. He also states that the causes seem to him nearly allied to those producing diabetes mellitus; and infers that the azoturia may pass into saccharine diabetes, though he says expressly (p. 100) that he has never seen this occurrence.

I have never seen a disease of this kind. All the cases of excessive urea I have seen have been either connected with pyrexia or with peculiarity of diet (excess of nitrogenous substances), or have been examples of diabetes insipidus with excess of urea, and therefore not belonging to Prout's category of excess of urea without excess of water.

A case, however, has been examined by my friend, Mr. Sydney Ringer, which appears to be an instance of this disease.

It was in a middle-aged man, weighing 109 lbs., and being only 5 feet 3 inches in height. He was not febrile, and appeared only feeble.

This man, when on good hospital diet (which is not, after all, very abundant), and tranquil in the wards, passed in each twenty-four hours (mean of twelve days)—

Urine.		Urea.
2739 c.c.	...	73·196 grammes,

or no less than 1130 grains of urea in each twenty-four hours, or 10·36 grains to each pound avoirdupois of body-weight! The hourly amount of urea was greater in the day than night. There was a trace of sugar, but not enough to determine quantitatively. It seems difficult to call this case diabetes mellitus. Is Prout's conjecture correct, and is this case about to merge into saccharine diabetes? Is the urine large enough in quantity to bring it under the heading of "Diabetes Insipidus," or are we to look upon it as a typical example of azoturia?

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[1] On Urinary Diseases, 1838.

SECTION VI.

URINE CHARACTERISED BY EXCESS OF URIC, OF HIPPURIC, OR OF PHOSPHORIC ACID.

An increase of uric acid occurs in pyrexia, in leucocythemia, in certain chronic liver diseases, and after an attack of gout, &c. But, apart from these cases, is there any disease distinctively marked by a permanent excess in the amount of uric acid? I believe not. The cases of supposed excessive production of uric acid are instances of elimination after retention in the kidney tubes or pelvis, or even sometimes in the bladder.

The cases of presumed excess of hippuric acid were observed at a time when the great amount of this acid in normal urine was not known, and when the ease with which hippuric acid is produced from benzoyl compounds was not understood. It is extremely doubtful whether there is a disease characterised by excessive formation of this acid. The doctrine of a "phosphatic diathesis" is now known to be erroneous. The phosphates precipitate simply from deficiency of acid, or excess of alkali, and their appearance is especially connected with lessened digestive power and impaired nutrition, or with urinary conditions, such as slight cystitis, leading to ureal decomposition. On this point, however, enough has already been said. The so-called "oxalic-acid diathesis" has been discussed in a previous page.

CHAPTER V.

RENAL DISEASES.

SECTION I.

ACUTE DISEASES.

Acute Bright's Disease.[1]

In the early stages and at the height of the disease, the urine in this disease presents intensely febrile characters; it is small in quantity, deeply pigmented, and deposits urates. It contains a variable but usually a large amount of albumen and blood; there are sediments of desquamated kidney-, ureter- and bladder-structures, and voided renal cylinders; sometimes it contains large masses of coagulated fibrine, or partly decolorized clots.

Normal constituents.

1. The water during the early severe febrile stage is extremely scanty.

2. The urea is sometimes very much augmented, as in other fever cases (Mosler, Beneke), while in other instances it is below the normal amount.[2] This occurs in cases with a large amount of albumen, and in which a great number of the renal tubes

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[1] This term is used in the sense in which it is employed by Rayer and Frerichs, to denote an intense febrile disease, which may come on after scarlatina and other exanthemata, or independent of these, and which is marked by signs of intense congestion of the kidney, with exudation and hæmorrhage into the tubes, and desquamation of the epithelium; the secondary phenomena are uræmic symptoms, to a greater or less degree, and, in the majority of cases, general dropsy. Acute desquamative nephritis is the term used by Johnson; inflammatory dropsy, by many writers.

[2] Frerichs gives 9·99 grammes of urea, as the mean of two experiments; Becquerel 9·49 grammes (Frerichs); and Gorup-Besanez 21·74 grammes. The deficiency of the urea has been noticed by many writers, especially by Christison, Scherer, and Renges (Valleix, Guide du Med. prat., t. iii, p. 423).

are blocked up by exudation. That it is not owing to lessened formation of urea, but to impeded exit, is evident from the uræmic symptoms which are always present in such cases, and which increase and prove fatal, if the elimination continues deficient. A case observed by Mosler[1] gives the best example of this I am acquainted with.

A man aged forty-five, never before sick, had great anasarca brought on by cold. When admitted at the height of the disease, the action of the eliminating organs was as follows (average of three days):

Insensible perspiration, skin and lungs .	675	grammes.
Urine	1196	„
Fæces	441	„

The fæces were thus increased, but not sufficiently so to compensate for the diminution of the urine and insensible perspiration. Some elimination, however, took place from the stomach; for there was vomiting to the mean extent of 200 grammes (6¼ ounces) in twenty-four hours.

As the patient was very thirsty, he drank largely.

The ingesta were, in twenty-four hours .	4164	grammes.
The egesta „ „ „	2385	„
Daily increase in weight . .	1779	„

In three days, therefore, the body gained 11 pounds in weight, simply from deficient elimination.

The composition of the urine was—

Quantity . . .	1196 c.c.	
Sp. gr. . . .	1010·38	
Colour, blood-red.		
Albumen, abundant.		
Urea . . .	15·7 grammes,	or 242 grains.
ClNa. . . .	2·73 „	„ 42 „
Sulphates . .	1·31 „	„ 20 „
Phosphates . .	2·35 „	„ 36 „

On the following day, the chlorine disappeared altogether from the urine; the urea fell to 8·2 grammes, or 126 grains.

For the next three days, the mean was—

Quantity . .	700 c.c.	
Sp. gr. . . .	1013	
Urea . . .	9·3 grammes,	or 143·5 grains.
ClNa. . . .	1·1 „	„ 17 „
Phosphates . .	1·7 „	„ 26 „
Albumen, still increasing.		

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[1] Archiv des Vereins für wiss. Heilk., Band ii, p. 535.

The symptom of uræmia then became extreme; there was dry tongue, great thirst, and uræmic bronchitis. Before death, the urea diminished to 3·6 grammes, or 55·5 grains, in twenty-four hours.

In this case, the cause of death was simply the mechanical impediment to the exit of the urinary constituents; the number of casts in the urine was extremely small, and the channel for the urine was not freed by their elimination.

3. The uric acid is increased (except in great retention); and owing partly to this, partly to lessened water, sediments of urates are common. The exact amount of increase is not known.

4. Nothing is known about the hippuric acid.

5. The pigment is often in large amount, and the scanty urine is very deeply coloured. In many cases, however, the presence of transuded hæmatin hides the colour of the pigment.

6. The chlorine is lessened, and often disappears altogether (Mosler and Heller). Like the urea, it is retained, and appears in large amount during recovery.

7. The sulphuric and phosphoric acids and bases are lessened.

Abnormal constituents.

Albumen is always present in large amount. When the urine is very scanty, it becomes almost solid by heat. Frerichs (p. 55) gives the range as between 5 and 25 grammes (77 and 386 grains) in twenty-four hours.

The sediments are usually characterised by the large amount of blood-corpuscles, of renal and vesical epithelium, of pus and granular cells; the cylinders are sometimes very numerous, and are intimately mixed with blood-cells or with sediments of urates or oxalate of lime (Johnson). From the great amount of epithelium which often adheres to these casts, Dr. Johnson calls them "epithelial casts." These characters (viz., the epithelium, blood, and urates) distinguish the casts of acute Bright's disease almost perfectly from those of the chronic form.

When the disease is about to end fatally, the quantities of water and of the solids decrease, the diminution in the solids being more considerable than that of the water; the albumen decreases least, and often is very abundant till the last.

When recovery is about to take place, diuresis usually occurs; and often an enormous quantity of water is passed, containing much urea and chloride of sodium.[1] As the diuresis thus arising does not appear to differ from that seen during recovery from anasarca arising from other causes, it is described under one of the forms of "Diuresis, or Diabetes insipidus."

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[1] In one of Brattler's cases (Urologie, p. 50), the water during recovery amounted to 7920 c.c. (= 255 fluid ounces) on one day, and was little below this on several other days.

During recovery, the albumen frequently disappears altogether, and the kidneys then recover perfect health; sometimes the urine remains albuminous for some time.

Effect of Remedies.

Alkalies appear to have a beneficial and eliminating effect, and not to be injurious. Hoppe,[1] in a case which came on after delivery, and in which the quantity of urine was 825 c.c., and the amount of albumen 3·4 grammes, or 52·5 grains, in twenty-four hours, found the bicarbonate of soda increase the water to 1100, to 2000, and finally to 3000 c.c.; the albumen gradually disappeared. The acetate of potash has sometimes the same effect.

Fomentations of infusion of the leaves of digitalis, as recommended by Christison, have been found by Prof. Vogel to increase enormously the amount of urine in a case with suppression of urine.[2]

In a case in which the dropsy had disappeared, and the diuresis had diminished, I tried the effect of gallic acid for fourteen days, and of the tincture of sesquichloride of iron for nineteen days; the following was the result:

In twenty-four hours, in ounces and grains.

	After 75 grains of gallic acid.	After 255 grains of gallic acid.	After 375 grains of gallic acid.	After ʒiiiss of tinct. of the sesqui-chl. of iron.	After ʒii of the tincture.	After ʒiʒiss of the tincture.
Quantity ...	32	45	41	38	39	36
Specific gravity ...	1025	1020	1025	1023	1025	1023
Solids	594	652·9	639·8	463	666	...
Albumen ...	15 5	11·4	14·5	5·9	4·48	3·42
Urea	...	...	457	...	465·5	421 8
ClNa	...	...	129	...	...	112·2
SO_3	20·2	...	...	...	29·3	...

The gallic acid had no effect on the albumen or on the other constituents of the urine. The amount of albumen lessened from the use of the iron, and in a greater degree than would have been expected from the natural progress towards cure alone; the other ingredients were not affected by it. The beneficial effects of iron are particularly noticed by Basham and others.

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[1] Deutsche Klinik, 1854, No. 14.

[2] Quoted by Mosler, Archiv des Vereins, Band ii, p. 531.

SECTION II.

CHRONIC DISEASES.

Chronic Bright's Disease.[1]

Normal Urinary constituents.

1. Water.—At the very commencement of the chronic disease, the water of the urine is either normal in quantity or slightly lessened; with its progress, the water, as a rule, decreases (especially in cases with dropsy and uræmia (Christison, Rayer, Rees, Frerichs, Johnson, Vallon[2]). Sometimes, in uræmia, the urine is almost suppressed (Christison).

At the same time, there are certainly many exceptions to this general rule; and in some cases the urine is more abundant than usual, either at the onset or throughout. Thus, I have measured more than 100 ounces; and Rosenstein gives a case in which, on an average of eight days, 5400 c.c., or 174 ounces, were passed daily. The urea was not at all augmented. The causes of such varying excretion can be partly made out.

(*a*) The anatomical condition of the kidneys might be conjectured to have a predominant influence on the amount of water: in some kidneys the renal vessels remain pervious; in others many vessels are obliterated: in some, the walls of the vessels in the Malpighian corpuscles are normally thin; in others thickened excessively, particularly in the waxy kidney. In fact, we might have anticipated that in such conditions as these the principal cause of the variation in the water would be found. Yet, when we seek for decided evidence on this point, it is not very satisfactory; for in cases in which the after-death condition is given, the amount of urine has been measured with care, in scarcely any instance, a sufficient length of time to permit a true conclusion.[1]

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[1] This term is employed in its ordinary symptomatological sense, as indicating an organic disease, denoted during life by persistent albuminuria, and by the frequent appearance in the urine of blood, renal structures, and exudation and desquamative renal products, and having for its usual secondary symptoms dropsy and uræmia. The diseases thus grouped together by their symptoms are anatomically different; as the kidneys may be large or small, atrophic or not, with fatty, or albuminous, or lardaceous (amyloid) degeneration, and altered as regards vessels, tubes, and lining epithelium, in various ways. But as the conditions of the urine have not yet been perfectly connected with these anatomical states, I have not attempted to separate them.

[2] Vallon, Wien Zeitschrift, 1856, in twenty-five out of twenty-nine cases.

If from the table given below there is some reason to infer that in the highly atrophic kidney, when many vessels are obliterated, the urinary water is on an average lessened, it does not follow that on one particular day a large quantity may not be excreted; thus, in a most atrophic case, I have known on a single day as much as sixty ounces passed:

(*b*) An advanced period of the disease, and the co-existence of dropsy[2] and uræmia, appear to be associated with lessened water;[3] while, on the other hand, an improvement in dropsical symptoms is attended by more or less profuse diuresis.

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[1] The following are the only cases I can safely place here; three are taken from Frerichs, and six are my own:

Mean amount of urine in 24 hours, in fluid ounces.	Condition of kidneys on post-mortem examination.	Authority and Remarks.
19½	Atrophied	Frerichs, p. 202.
59	"Transition" form from 2d to 3d stage; size nearly normal	„ p. 260.
35	Atrophied	„ p. 273.
90	Large, 10½ and 9½ ounces ...	Author.
33	Medium, 5½ ounces each (lardaceous)	„ Much purging from elaterium during life.
33	Atrophied	Author.
23	Very much atrophied ...	„
34	Atrophied, 1 and 1½ ounces	„
47	Atrophied	„

[2] The statement of Rayer (op. cit., p. 143), that the water lessens when dropsy comes on, appears to be correct; but it is quite certain that many cases with scanty urine are not attended with dropsy. Thus, in twelve of my cases—

Mean amount of urine in twenty-four hours, and mean specific gravity.

In four cases with moderate anasarca.		In six cases with considerable anasarca.		In two cases without dropsy.	
Quantity.	Sp. gr.	Quantity.	Sp. gr.	Quantity.	Sp. gr.
Ounces. 61	1013	Ounces. 48	1017	Ounces. 28	1013·5

[3] The following table, taken from twelve of my cases, shows an obvious connexion

(*c*) Rosenstein[1] has noticed that the febrile or non-febrile condition of the patient has as great an effect in Morbus Brightii as in other cases, and that the urine is very much smaller in amount in the fever than in the fever-free patients. Yet, as many cases of Morbus Brightii, with a small amount of urinary water are quite feverless, this will only account for a few cases.

(*d*) The co-existence of other affections evidently influences the amount of urinary water; thus, organic diseases of the liver, heart, and lungs may either cause lessened rapidity of flow through the renal vessels, or may, with or without this, give rise to great variations in lateral pressure. Becquerel,[2] indeed, states that cirrhosis of the liver, heart disease, and pulmonary emphysema produce febrile (*i. e.*, high-coloured and scanty) urine in Bright's disease; and, if so, the presence or absence of these affections will have an important influence on this symptom. In some instances, again, on account, perhaps, of some condition of the mucous membrane of the alimentary canal, there is great thirst, and a large amount of fluid is taken in. Unless the kidneys be most extensively diseased, some of this excess will pass off by them.

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between lessened water and solids and uræmia. In these cases, no great fallacy was caused by the absorption of dropsical fluid:

Case.	Fluid ounces of urine in each 24 hours (mean of many days).	Specific gravity.	Uræmic symptoms.
1	90	1013	None.
2	74	1011	None.
3	69	1010	None.
4	53	1013	None.
5	49	1023	None.
6	49	1019	Slight.
7	47	1013	Marked.
8	38	1016	None; purged with elaterium.
9	34	1016	None.
10	33	1019	None; purged with elaterium.
11	33	1009	Marked.
12	23	1018	Marked.

If this series be divided into two sections, one with, and one without, uræmic symptoms, and if the two cases with elaterium purging be omitted, we have—

	Urine in 24 hours.	Specific gravity.
Mean of six cases without uræmic symptoms . .	61½	1014·3
Mean of four cases with uræmic symptoms . . .	38	1014·75

[1] Virchow's Archiv, 1859, Band xvi, p. 511.

[2] Traité de Chimie pathol., 1854, p. 366. The urine was febrile in four of twenty-two cases.

(*e*) The condition of the other organs eliminating water must have an effect on the amount excreted by the kidney, and perhaps, next to the anatomical condition, this is the main cause of the variation in the amount of urinary water. Sometimes there is spontaneous purging or vomiting, which would lessen it; much more frequently there is lessened skin exhalation, which would increase it. Thus, a case is recorded by Mosler,[1] the action of the various eliminating organs was as follows:

In each twenty-four hours.

	Grammes.	
Ingesta		2467 grammes.
Egesta—		
Urine	1154	
Fæces	335	
Insensible perspiration (skin and lungs)	1008	
		2497 „
Daily loss of weight .		30 „

		Health.[2]
The urine was to the fæces as	1 to 0·29	1 to 0·09
To the insensible perspiration as	1 to 0·87	1 to 0·70

So that while the fæces were somewhat increased (healthy average being 135 grammes, or 4¾ ounces), and the insensible perspiration slightly, the urine was lessened.

But the reverse case is much more common; and every one must have seen cases of Morbus Brightii in which the skin was extremely inactive,[3] and a large quantity of water was therefore emerging by the kidneys. The hot air in these cases causes temporary action of the skin, and the urine decreases in amount.

It is possible that the kidneys may stand in a double relation to the other water-excreting organs, and that while, on the one hand, imperfection in the action of these organs may increase the kidney action, there may be cases in which idiopathic diuresis merely robs the skin, intestines, and lungs of the water that should pass off from them, as occurs, for instance, in diabetes mellitus. But such diuresis in Morbus Brightii is certainly uncommon.

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[1] Archiv des Vereins für wiss. Heilk., Band xi, p. 513.

[2] These numbers are from Gross:
Valentin's proportions are—
Urine to fæces as 1 to 0·13
„ ins. persp. 1 to 0·86
Text-book, translated by Brinton, 1853, p. 325.

[3] G. H. Meissner (Schmidt's Jahrb., 1860, No. 1) has lately made precise experiments on this point, by absolutely collecting the sweat. In one case, no sweat could be obtained; in two others, an amount much below the normal.

Such, then, would appear to be the obvious causes which may influence the amount of urinary water: viz., the anatomical condition of the kidneys during the progress of the case; the presence or absence of general fever; the presence of other diseases, especially of the heart and liver; and the independent condition of the other water-excreting organs. And I believe that, accepting the rule that the water is lessened in Morbus Brightii, the certainly rather numerous exceptions to this may be explained by reference to one or other of these causes.

In addition, there may possibly be, in some cases, some alteration in the renal nerves.

The effect of the lessened exit of water by the kidneys is often very visible. To take two illustrations: One of my patients was thirsty, and took a large quantity of fluid into his system; the watery exit by both the kidneys and the skin was lessened, and the excess of water passed off by occasional excessive vomiting of copious watery fluid. In another case, not only the skin and kidneys, but the alimentary mucous membrane excreted less water than usual; there was intense paroxysmal dyspnœa; and, finally, rapid transudation of fluid into the right pleura, and, at the same time, passage of fluid from the intestinal mucous membrane.

In most cases, however, instead of vomiting, diarrhœa, or effusions into serous cavities, the hydræmia leads to dropsy. Other factors are often in action here, but there can be no doubt that the retention of water is one of the most important.

3. The Urinary Solids.—That there is generally a diminution of the urinary solids in Morbus Brightii, was a fact first explicitly pointed out by Dr. Bostock (in Dr. Bright's cases), and has been confirmed by Christison,[1] Prout, and succeeding writers. To this diminution there are, however, exceptions, as in the case of the water; but these variations will be best considered under the heads of the separate solids.[2]

The diminution affects all the ingredients, though in somewhat different degrees.

3. The Urea.—The lessening of this ingredient has been stated by most writers.[3] Frerichs has affirmed without reserve,

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[1] On Granular Degeneration, 1839, p. 48. On an average, the daily amount of solids (albumen, of course, not being considered) is considered to be lessened by one fourth or one sixth. My own cases very closely accord with this; the average amount of lessening being about one fourth.

[2] One exception may be noted here. Gorup-Besanez found in one case no less than 97·98 grammes of solids, fourteen days before death; the specific gravity was 1035. The urea was not in excess (21·74 grammes), but the fireproof salts were large (24·73 grammes), and also the extractives (26·02 grammes), and the albumen (25·13 grammes). As a general rule, Gorup-Besanez found the urea, uric acid, and salts lessened. Scherer, in Canstatt's Jahresb., 1849.

[3] Rayer (Mal. des Reins, t. i, p. 145) first pointed out that in precipitating the

"that the urea is constantly more or less below the normal quantity."[1] He gives the averages of seventeen analyses as from 0·97 to 16·98 grammes in twenty-four hours; the mean of the whole number contained in his book is 6·47 grammes, or 99 grains, in twenty-four hours. These analyses, however, did not extend over many days. Rosenstein's numerous and careful analyses,[2] in adults of both sexes, give a range between 1·04 gramme and 16·16 grammes in twenty-four hours; the mean amount of all the analyses is 7·26 grammes, or 112 grains, in twenty-four hours; and this agrees closely with Frerichs' mean result.

It appears also pretty certain that the lessening in the urea is greatest in the uræmic cases. Christison mentions a case in which hardly an ounce of urine, and therefore, necessarily, scarcely any urea, was passed; in a case of Frerichs, the urea was only 0·97 gramme in twenty-four hours, while Vallon states that in some of his cases the urea was altogether absent. Generally, however, even in uræmic cases, the excretion is somewhat greater than this, and the following case of Schottin[3] may be taken as a type of the usual excretion:

In twenty-four hours there were excreted—

	Water.	Urea.	Inorg. salts.	Albumen.
	c.c.	Grammes.	Grammes.	Grammes.
Two days before death... ...	193	6·04	1·09	1·43
The day before death	270	6·75	1·39	1·86

Urea, in this instance, was found largely in the saliva. Usually, perhaps, in uræmia, as in the above case, the lessening of the urea is coincident with lessened water; but sometimes this coincidence is not seen, and a large flow of water is accompanied by very little urea. A patient of mine, five weeks before death, excreted in twenty-four hours—

1054 c.c., or 37 fluid ounces, of urine,
8·432 grammes, or 130 grains, of urea,
4·216 „ or 65 „ of ClNa.

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albumen, a small quantity of urea falls with it. This makes the urea appear perhaps less than it really is, but the error is trifling.

[1] Loc. cit., p. 62.

[2] Virchow's Archiv, 1859, Band xvi, p. 213.

[3] Beiträge zur char. der Uræmia; Vierordt's Archiv für phys. Heilk., 1853, p. 170.

Here the great disproportion between water and urea excretion is very well seen, and similar cases are not uncommon.

The lessening in urea being the rule, especially in uræmic cases, it is certain that, as in the case of the water, there are important exceptions.

Thus, in one of my cases, in an advanced stage of the disease, there were excreted (mean of two days) in twenty-four hours, the temperature being febrile (1° to 2° constantly over the normal)—

Albumen	422·8 grains,	or 27·3 grammes.
Non-albuminous solids .	981 „	or 63·5 „

Schottin[1] mentions an instance in which there were uræmic symptoms, and yet, seven days before death, no less than 26·28 grammes, or 305 grains, of urea were excreted (with 17·3 grammes, or 267 grains, of albumen). The temperature is not given.

In the anasarcous case of Mosler, formerly referred to, the mean of three days' observation was—

Urea . .	40·2 grammes,	or 620 grains.
Cl . .	5·6 „	86·4 „
SO_3 . .	1·85 „	28·7 „
PO_5 . .	4·32 „	66·6 „

The patient's temperature was only 93·3° Fah.; his weight, 44½ kilogrammes; his pulse was 103; his breathing power was small.

These and similar cases seem to be explicable in one of the following ways: either there is a febrile condition causing increased disintegration, giving rise to greater formàtion and elimination of urea;[2] or there is partial absorption of dropsical fluid (containing urea, or albumen which breaks down into urea); or the increased amount of urea is simply owing to a temporary increased elimination, following a period of unusual retention. None of the cases of abundant urea have been examined during many days, and it is not at all unlikely that, in some of these cases, had the observations been continued, the large amount of urea would have been subsequently compensated by a corresponding small excretion.

These causes seem to account for most cases, and, in addition, although this has not been properly noted, it is not improbable that diet may have had some influence.

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[1] Loc. cit., p. 170.

[2] This is, however, denied by Rosenstein (Virchow's Archiv, Band xvi, p. 213). I believe it will be found correct, but additional observations are needed.

If we admit that the increased flow of urea can be explained by reference to one or other of these causes (and, apparently, this can be done in the cases now on record), the general rule remains good, that in Morbus Brightii the urea is lessened in amount.

As there is no doubt that the urea in the blood is increased,[1] it seems pretty clear that the urea in Morbus Brightii is still formed to a considerable amount, and that its lessening in the urine is in part owing to retention from simple impediment to diffusion through the diseased renal vessels and tubes. But it is a problem of great interest and difficulty to decide whether there is, in addition, a lessened formation. In the history of Morbus Brightii are many reasons for believing that the nutrition of tissues is early and deeply affected. The only way of satisfactorily settling this point would be by a rigorous determination of the amount of nitrogen entering the system, and leaving it by any channel—kidneys, skin, or intestines. This question can hardly be decided by a consideration of the urine alone; but it must be said, that it is quite clear that the urea and the other urinary ingredients are often very much lessened for a long time, without there being any uræmic symptoms or other signs of blood-poisoning, which would necessarily occur if a normal amount of urea were formed, and if half only, or even less, were discharged, as in several of the cases on reco[illegible]. In such cases, although there is, doubtless, retention, there cannot be such an amount of urea in the blood as must be the case if the *only* change were want of elimination.

The influence of the anatomical condition of the kidney on the amount of urea is not yet made out. As the amount of water is least in atrophic cases, and as the specific gravity is no higher, it would seem likely that there is a less amount of urea in such cases than in the urine of the large fat-granular and lardaceous kidney. But this is merely a presumption. It is generally assumed that the urea lessens with the progress of the disease.

The amount of urea sometimes is increased in a great degree during diuresis, in dropsical cases. (See "Diabetes Insipidus.")

4. The uric acid is, as a rule, lessened even more than the urea,[2] and sediments of urates are uncommon.[3] As it accumu-

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[1] Exceptions have been justly made to Picard's experiments, but the older observations on this head seem quite convincing (Bostock, Christison, &c).

[2] Perhaps on account of its less diffusibility.

[3] Prout noticed this, especially in the cases he termed anæmotrophic, *i. e.*, "kidney-

lates in the blood (Garrod and others), it is, no doubt, in part formed and retained. But whether there is any lessening in its formation is unknown.

Occasionally the uric acid is in excess. Frerichs noted, in one instance, 1·27 gramme, or 19·6 grains, in twenty-four hours. Perhaps this was merely a great discharge after a long period of lessened elimination.

5. The alterations in the hippuric acid are not known.

6. The pigment and extractives are generally also lessened, as pointed out by Becquerel and others;[1] and this, no doubt, occurs in part from the same cause as the lessening in the urea, viz., from impeded passage through the renal capillaries. But, in addition, it is evidently sometimes the effect simply of the anæmia, and of lessened formation of pigment from blood. The blood-corpuscles lessen in number, and the pallor of confirmed Bright's disease is well known. In some instances, the urine of chronic Bright's disease is brownish, or even reddish in colour, not, however, from normal pigment, but from altered hæmatine. (See "Abnormal constituents.")

The alterations in the creatin and creatinin, and in the various substances included under the "extractives," are unknown.[2]

7. The salts are also lessened in amount.[3] The chlorine, in Rosenstein's cases, was more diminished than could be accounted for by the diet. It appeared to be in an inverse ratio to the amount of albumen. One cause of lessening is, no doubt, to be found in the dropsical effusion, which contains much chloride of sodium, and inversely, during the absorption of this fluid, immense quantities of the chlorides pass off by the kidneys. The phosphates and sulphates are also small. Occasionally, however, as in the case quoted from Gorup-Besanez, the fireproof salts are in large amount, from causes yet uninvestigated.

8. The acidity of the urine is lessened; and this fact, with the lessened excretion of uric acid, accounts for the infrequency of sediments of urates. The diminution varies. Mosler (in the case formerly quoted) found it equal, in twenty-four hours, to 0·66 grammes of crystallized oxalic acid, while the acidity of healthy urine is from 2 to 4 grammes. But here, as in all

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degenerating, with defective sanguineous nourishment" (5th edition, p. 137). Rees found the uric acid generally decreased; sometimes not so. See also Rayer, on the infrequency of deposits of urates.

[1] Sémiotique des Urines, 1841. Frerichs, Die Nieren-Krankh., 1851, pp. 63, 64. Vallon, Wien Zeits., 1856, xii, p. 1.

[2] Since the above was printed, Schottin's observations on creatin have been published, and will be found under the head of "Corrections and Additions."

[3] Rayer and Frerichs, loc. cit. Beneke, zur phys. und path. des phosphors. und oxals. Kalkes, 1850, p. 27. Heller.

other cases, there are exceptions. In a febrile chronic case, with a large excretion of solids, I found the acidity as great as usual; it equalled in twenty-hours the acidity of 2·95 grammes, or 46 grains, of crystallized oxalic acid. Still, as this was a febrile case, it was not, perhaps, a fair one. But in another chronic a-febrile case, the acidity was equal to 2·4 grammes, or 37·4 grains, of crystallized oxalic acid. The explanation of this, however, was perhaps to be found in some peculiarity in digestion, as the acidity increased greatly in the second hour after food, instead of falling, as in health; (it rose to what was equal to 0·211 grammes of oxalic acid in the hour, equivalent to 5 grammes in twenty-four hours). This subject, however, requires more investigation.

9. The odour of the urine is often very peculiar; it is fishy, or like water in which meat has been boiled sometime before. This odour is probably connected with decomposition of the albumen. A similar odour occurs in cases of slight cystitis.

On the whole, it appears probable that the effect of the a-febrile Morbus Brightii on the ordinary urinary constituents is chiefly owing to the physical condition of the kidney. But whether want of diffusion and transit expresses the whole phenomena, and if so, whether the determination of the amount of the constituents is an exact measure of the obstructive affection of the kidney, is not known. Until the metamorphosis of the nitrogenous tissues in morbus Brightii is better understood, it is best to leave the question of the possible lessening of formation of urea and uric acid undecided.

Abnormal constituents.

10. The principal morbid constituent is dissolved albumen, which exists in various conditions, and gives different reactions with the usual tests, heat and nitric acid; sometimes it is entirely precipitated by heat and a moderate quantity of nitric acid; at other times, after precipitation by heat (from an acid urine), it is entirely soluble in a moderate amount of nitric acid.[1] As pointed out by Rayer[2] and Dr. Bence Jones, a very minute quantity of nitric acid will prevent its precipitation by heat; and, as shown by Prout, Bence Jones, Beneke, and Rees, it is sometimes precipitated by nitric acid, and not by heat.

Its most usual condition is, however, that in which it is precipitated by heat from a urine naturally sharply acid, or made so by a moderate quantity of nitric or acetic acid; and all other states may be at present considered to be modifications of this. When albumen is experimented with, it can be made to pass through various phases of solubility and insolubility, from the actions of acids, alkalies, and salts, without its real nature or composition being in any way altered; and as such influences will act on it more or less in every urine, it by no means follows, when the albumen in the urine of Bright's disease presents modifications in its reactions with reagents, that it is in any very peculiar or unusual condition.

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[1] Martin Solon, Becquerel, Herard (L'Union Méd., 1859, Août). This has been denied by Rayer at one place (tome i, p. 139), but affirmed at another (tome ii, p. 114, footnote).

[2] Traité des Maladies des Reins, 1839, tome i, p. 137, footnote.

Occasionally, however, the albumen in the urine of Bright's disease may be in a state corresponding to Mialhe's "albuminose"[1] or Lehmann's "pepton," viz., when it is altogether incoagulable by heat and acids. Descriptions occur in some writers of "peculiar extractives," which seem to apply to albuminose. But the great difficulty of separating albuminose from the urinary constituents, and from common albumen, has hitherto prevented any thorough examination.[2]

The amount of albumen in the urine varies very much; its range is from 5 to 545 grains (·35 grammes) in twenty-four hours.[3] The range in Frerichs' cases was between 3·81 and 18·6 grammes (59 to 286 grains); in Rosenstein's cases the range was from 0·50 to 18·9 grammes. The mean of Schmidt's cases was 13·25 grammes, or 204 grains; of those of Gorup-Besanez, 15·36 grammes, or 237 grains.[4] The per-centage amount varies from 0·1 to 3 per cent. It is stated by Heller, that it exists sometimes in such great quantities as to be in greater relative quantity to the water of the urine, than the albumen of the blood is to the water of the serum!

In any particular case the amount varies greatly from day to day.[5] It is often increased during the day, perhaps from movement or from food. In several cases I have found that, if the bladder be emptied in the morning, the albumen in the urine secreted during the next hour before food is small, or is entirely absent. The influence of food upon it is in some cases very well marked. I have noticed it very greatly increased in the second and third hour after dinner.[1]

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[1] Mialhe, Chimie appliquée à la Phys. et à la Thérapeutique, 1856, pp. 128—184.

[2] Mialhe, whose reputation as an accurate observer does not stand very high, regards "normal albumen" as the sign of a profound disorganization; the "modified albumen," which is the most common condition in Morbus Brightii, according to Mialhe, as produced by "vitiation of fluids;" and albuminose, as the sign of another disease (albuminosuria) produced by imperfect digestion.

[3] This amount occurred in one of my cases; it is the largest quantity I have ever seen noted in any analysis.

[4] Quoted by Frerichs, p. 61.

[5] See Frerichs, Supplement, pp. 272, 273. The extremes in one case examined during sixteen days were 5·208 and 16·83 grammes.

This effect of food I have noticed now in a large number of cases; it is not, however, quite constant, nor does it occur in the acute cases. The albumen passed soon after food is also often in a peculiar condition; less perfectly coagulable by heat, and sometimes seems to approach the albuminose of Mialhe.

In 1853, Gubler observed the influence of food, but his observations were not published.

In 1857, Luton[2] published an elaborate paper on this subject, giving an account of Gubler's cases, and adding many of his own. In the majority of the cases the urina sanguinis contained no albumen, while the deeper-coloured urina cibi contained a large quantity; and Luton does not hesitate to ascribe to this phenomenon an important influence on the genesis of Bright's disease.

The frequency of this occurrence is thus placed beyond doubt, and it is worthy of attention.

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[1] See two clinical lectures in the Medical Times and Gazette, for April, 1852, and April, 1854. I subjoin the analyses from the last lecture to show the amount of increase which can occur. The amounts are given in fluid ounces and grains:

CASE I.

	First experiment.		Second experiment.	
	In one fasting hour—fifteen hours after food.	In the second hour after food.	In the fifteenth hour after food.	In the second hour after food.
Water	3⅓ fl. ozs.	3⅔ fl. ozs.	1⅔ fl. ozs.	2⅔ fl. ozs.
Albumen ...	14·311 grs.	34·069 grs.	11·229 grs.	30·421 grs.
Other solids ...	54·479 „	62·003 „	45·882 „	55·408 „

CASE II.

	First experiment.		Second experiment.		Third experiment.	
	In a fasting hour.	In the second hour after food.	In a fasting hour.	In the third hour after food.	In a fasting hour.	In the second hour after food.
Water ...	4⅔ fl. ozs.	4⅓ fl. ozs.	4 fl. ozs.	2⅓ fl. ozs.	4¼ fl. ozs.	1⅔ fl. ozs.
Albumen ...	9·281 grs.	17·262 grs.	4·687 grs.	6·750 grs.	7·050 grs.	5·231 grs.

In the third experiment of the second case, the albumen was decreased after food, but it so happened that the amount of urine passed was very small.

[2] Gazette Médicale de Paris, 1857, p. 546, et seq.

Is this merely owing to increased congestion, or to some condition in the albumen poured into the blood after a meal, which is more favorable to diffusion than the serum-albumen in the fasting animal?

In the lectures formerly alluded to, I used the term "food and blood albuminuria," to express the two sources of albuminuria, and Luton's observations and remarks seem to warrant the use of the term.

It can scarcely be doubted that the structural disease of the renal capillaries, originating in various ways, is the common cause of the passage of albumen; and that in many cases the varying amount of albumen must be attributed to differences in the amount of congestion, *i. e.* of lateral pressure. But is there some special state, by reason of which albumen may pass off through sound capillaries? Crude albumen injected into the blood will thus exude (Bernard). After a moderate meal the congestion of the kidney could perhaps scarcely be so increased as to double the amount of albumen, and yet this occurred in one of my cases. During the absorption of exudations (pneumonia, &c.), albumen will suddenly appear in the urine, last a few hours, and then disappear, without any other circumstance indicating any affection of the renal capillaries. Is the albumen in such cases like a foreign body which passes through membranes, as quinine or iron, or any other substance, may do?

The amount of albumen and the period of the disease show no constant relation. Yet, as first noticed by Christison, there is a tendency to a larger excretion in the early stages than in the latter ones. Sometimes, however, even at last there is much albumen.

The proportion between the albumen and the normal constituents of the urine is extremely variable. At present certainly no general rule can be laid down, except that when the albumen is in large quantity, the uric acid and the chlorides are usually very small. The urea is sometimes in some quantity even when the albumen is also large in amount, and on the other hand, in uræmic cases both urea and albumen are often both in small quantity. Certainly, nothing like an inverse ratio between the urea and the albumen can be perceived.

In a certain number of cases, the albumen may disappear from the urine. This fact was noted by Bright, and then by Christison, and it has been subsequently observed by Rayer,[1] Rees, Malmsten, Johnson, and others, so that the correctness of the statement is undoubted. One of the latest observers (Vallon) who has written on this subject found the albumen absent in two out of twenty-nine cases.[1]

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[1] Mal. des Reins, tome ii, p. 567.

Virchow mentions a case of intermittent albuminuria, though it may be questioned whether the case should be considered one of chronic Bright's disease.

The cause of the disappearance of the albumen is extremely obscure; we must rest contented at present with the hypothetical explanation of greater inpermeability of the capillaries and diminution of congestion and lateral pressure. According to Frerichs (p. 62), the detachment of the fibrinous casts goes on when the albumen has disappeared. I can confirm this observation so far, that I have seen abundant casts with a very small quantity of albumen. Are these casts newly formed, or are they merely old ones which have been retained for some time?

11. Fat in large quantities, so as to make the urine turbid, is not common[2] in the urine of chronic Bright's disease; when it does occur, it is sometimes after a large amount of oil has been taken. Sometimes, however, this does not appear to have been the case. In smaller quantities, however, fat is very common, and is derived directly from the kidneys. It is in the form usually of oleine. Sometimes cholesterine can be obtained by chemical process,[3] though this substance is seldom, if ever, present in a free state. Most generally the fat is mixed up with albuminous substances, or is contained in epithelial or other cells, and is microscopically visible. The quantity in the urine is very variable. Kletzinsky[4] found 0·026, 0·127, 0·035, 0·037, 0·024, 0·028 per cent.

12. Sugar is sometimes found in cases not obviously diabetic. The frequency of its occurrence is not known. Inosite was discovered in one case, in a woman, by Cloetta.[5]

13. A brownish or reddish tint, from dissolved blood-hæmatin, is not unusual. Generally, such urine is highly albuminous.

Abnormal pigment.—In no inconsiderable number of cases a substance is in the urine which gives a violet or brownish colour when the urine is boiled with a small quantity of nitric acid.[6] It is not, however, in great amount; and it is only seldom that, on exposure to the air, the urine becomes bluish, and deposits a blue or black sediment.

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[1] In at least thirty cases of chronic Bright's disease, I have never found the albumen absent in the twenty-four hours' urine, though occasionally it has been in very small amount. In some cases, in which there were other diseases, and in which the condition of the kidneys was uncertain, I have known the albuminuria intermit. Heller, also, has never seen it absent.

[2] Rees (On Diseases of the Kidney, 1850, p. 52) observes that he cannot satisfy himself that oily matter is frequently to be found in the urine. Frerichs, in quoting a case from Rayer, remarks that he has never seen a similar one (p. 59).

[3] Beale.

[4] Archiv für phys. und path. Chem., von Heller, N. F., 1852, p. 287.

[5] Schmidt, Jahrb., 1857, No. 4, p. 10.

[6] This is the uroxanthin and uroglaucin of Heller, who has insisted particularly on

14. Morphological elements.[1]—Epithelium from the kidneys and pelvis, granular and pus cells (rarely), cylinders, and blood are mixed with more or less epithelium from the bladder. Sediments of urates are rare; óf oxalate of lime not uncommon. For a description of these bodies, a previous page (p. 202) is referred to.

The stage of the disease can sometimes be inferred from these sediments. Great desquamation of epithelium, or adherence of epithelium to a cylinder, indicates an earlier stage than do the bare casts and little epithelium. The cast of large diameter indicates, according to Johnson, that the tubule has lost its epithelium, while the small cast comes from the centre of a tubule still clothed with epithelium; a large quantity of fat may imply fatty degeneration, and a complete absence of fat and epithelium may indicate the greatest amount of atrophy and previous desquamation. Yet these differences are not to be depended on for an absolute distinction of various states; in the same case, and almost on the same day, the casts may vary very much, for different parts of the kidney furnish very different contingents to the sediments.

Blood is stated by some writers (Johnson) to be uncommon. I have seen it, however, in small quantities in a considerable number of cases. The so-called "corpora amylacea" were discovered by Münch[2] in the urine of a man; they were found every day, were very numerous, and were coloured blue by iodine and SO_3. After death the kidneys contained corpora amylacea as did also the liver and spleen; it was a case of advanced lardaceous (amyloid) disease.

Incidental circumstances affecting the urine in Bright's disease.

a. Inflammations and effusions (which always contain urea) diminish, as already intimated, the amount of urine and the solid constituents. It has been, however, stated by Becquerel that, during such inflammations, the urine becomes febrile, and often deposits uric acid.[3] The effect of the febrile state in

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the occurrence of these pigments. (See "Abnormal pigment.") Archiv für phys. und path. Chem., N. F., 1852, p. 259.

[1] For an excellent account of these elements, and for some good, though too well defined, illustrations, I beg to refer to Dr. Basham's highly practical work on kidney disease.

[2] Correspondenz Blatt des Vereins für gemeinsch. Arb. zur ford der wiss. Heilk., No. 16, 1855, pp. 195—197, and No. 17.

[3] Traité de Chim. path., 1854, p. 367.

lessening the amount of water has been also pointed out by Rosenstein.[1]

b. The removal of dropsical effusions increases sometimes to a great amount the quantity of water and of chloride of sodium. The special characters of the urine in such cases have been considered under the head of "Diuresis."

c. The condition of other eliminating organs produces a great effect. Exercise and warmth, by increasing cutaneous action, lessen the amount of urine; and spontaneous vomiting or diarrhœa has, to a certain extent, the same effect.

d. Effect of food and medicine.—According to Heller, vegetable food, alkalies, and diuretic medicines generally, increase the quantity of albumen, while animal food and alum (recommended by Oppolzer) lessen it.[2] Mineral acids are also, according to Heller, useful, but there is no evidence at present that they lessen the albumen (Zimmermann.)

Mosler[3] found gamboge increase the intestinal excretions to about double, and lessen the water and the solids of the urine. The chlorine was especially affected; in fact, it disappeared from the urine. The urea was lessened by about one twelfth; the phosphoric and the sulphuric acids and the free acidity were not affected. The amount of albumen, in spite of the lessened water, remained the same.

Purging from elaterium, in my experiments, reduced the quantity of water, but did not obviously affect the albumen. Sampson[4] has spoken highly of gallic acid, under the use of which he has seen the albumen disappear. I have tried tannin and gallic acid without any marked effect. A man passing on an average 79 ounces of urine, with a specific gravity of 1011, took tannin for seventeen days, at first 15, then 30, then 45 grains daily, and in the last forty-eight hours of the experiment he had 105 grains; the water and specific gravity averaged 77 ounces and 1011, being almost the same; the albumen remained unaltered. He then took gallic acid for ten days, in doses of 15 and then 30 grains in twenty-four hours; the water averaged 66 ounces, viz., 11 ounces less; the albumen was unchanged.

The preparations of iron, especially the tincture of the sesquichloride, appear to reduce the quantity of water, and probably the albumen in some instances; but perhaps this is only in anæmic cases, when the urinary symptoms are temporarily increased by the deficiency in blood particles.

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[1] Virchow's Archiv, 1859, Band xvi, p. 211.

[2] Archiv für phys. and path. Chem., N. F., 1852, p. 336.

[3] Archiv des Vereins, Band ii, p. 513.

[4] Lancet, Dec., 1849.

It has been stated that several substances which ordinarily pass into and give an odour to the urine, such as asparagus, oil of turpentine, &c., do not do so in Bright's disease.

It has been also asserted by Dr. Speck,[1] that iodine does not pass. At present, this has not been confirmed.

SECTION III.

IDIOPATHIC RENAL ABSCESS.

This rare affection is scarcely ever accompanied by pus in the urine;[2] most of the cases of great sudden discharge of pus have been instances of calculous pyelitis, in which accumulations, produced by the blocking up of the ureter, or of some calices, have been allowed to pass off by the shifting of the stone. No analyses of the urine have yet been made in abscess in or about, and communicating with, the kidney.

SECTION IV.

PYELITIS.

In calculous pyelitis the urine varies much, according to the stage of the disease, the degree of obstruction of the urine, the condition of the kidney, the exact position, size, and moveableness of the stone, the amount of coincident bladder disease, &c.

The existence of blood in greater or less quantities, albumen, epithelium from the pelvis, pus and granular cells, are the usual abnormal constituents of the urine. They form a whitish or white-brown, dense, or flocculent sediment, which is often copious, though generally less so than in cystitis.

Some of these may be absent, and all may be wanting when the stone is firmly fixed. The existence of pelvic epithelium is a valuable diagnostic sign; but the other conditions are not diagnostic, unless taken in conjunction with the other symptoms of the disease, and with the negative evidence that the bladder is unaffected.

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[1] Correspondenz Blatt des Vereins für gewiss. Heilk., No. 40, October, 1859.

[2] Valleix states positively, for example, that the presence of pus in the urine is a sign of pyelitis or cystitis, and not of suppuration of the kidney (Guide du Med. prat., tome iii, p. 386).

The amount of albumen in pure pyelitis is proportioned to that of the pus or blood; but very frequently the signs of pyelitis are combined with those of congestion or degeneration of the kidney; the amount of albumen is then much greater, and the evident disproportion between its amount and that of the pus or blood which may be present proves the co-existence of renal disease.

When the obstruction of the ureter is complete (either by stone or acephalocyst), the urine and pus accumulate above and distend the pelvis and calices. All the urine that is passed comes from the sound kidney, and is clear and free from deposit. The *sudden* change from a purulent to a clear non-sedimentous urine may lead to a diagnosis of this condition; if the bladder be coincidently affected, of course the pus will not disappear.

In pyelitis from other causes than calculus, there is no diagnostic sign, except the pelvic epithelium. Slight pyelitis, leading to desquamation, is extremely common in cases of acute and sub-acute Bright's disease, and in cystitis.

SECTION V.

ACUTE CYSTITIS.

The urine is scanty and high-coloured, as in all febrile maladies; there is a white or yellowish-white deposit of epithelium, pus, and granular cells. Blood in any quantity is rare, but some blood-globules are usually seen on microscopic examination. There is a little albumen in proportion to the amount of pus.

SECTION VI.

CHRONIC CYSTITIS.

The urine is in normal amount; is acid when passed, but soon becomes alkaline from the decomposition of the urea; its colour is sometimes pale or natural, but very often it is darker than usual, and in some cases (sub-acute) it has a reddish-brown hue, as if it contained dissolved hæmatin; this is not the case, however, for the amount of albumen may be extremely small.

There is a large deposit of pus; as long as the urine is acid, this forms a white or yellowish sediment, which, under the microscope, presents only pus-cells, with some imperfect epithelium; sediments of urates are not common. When the urine becomes alkaline, the pus becomes viscid, tenaceous, and stringy; phosphate of lime, ammoniaco-magnesian phosphate, and sometimes urate of ammonia, are deposited among the pus-cells; the colour of the sediments becomes greenish or brown. After some hours, the sediment runs together so completely, as to form one single glairy mass.

Sometimes in feebly acid urine, the pus within the bladder takes on this viscid and tenacious character; it may then block up the urethra at the commencement of micturition; more often it is discharged at the end of micturition, and forms tough, whitish threads, which are pulled out of the urethra.

Albumen exists in small quantities in the supernatant liquid. Blood is not often present if there be no calculus, and is always in microscopic amount.

It is often extremely difficult to know if, with the cystitis, there is pyelitis or disease of the kidney itself. Pyelitis must be distinguished by other symptoms, or by the existence of pelvic epithelium. Disease of the kidney can only be distinguished by the amount of albumen being manifestly greater than could be furnished by the pus, and by the discovery of casts or renal epithelium.

The urine in chronic cystitis, apart from the structures mechanically suspended in it, is not, as far as is known, altered in composition.

The alkalinity in cystitis is often owing to ureal decomposition, but in addition, as pointed out by Dr. Owen Rees,[1] the mucus poured out from the mucous membrane is itself alkaline, and either lessens the acidity, or is sufficient *per se* to make the urine alkaline.

A peculiar faint, nauseous odour is often perceived, and appears to arise from changes in the mucus or albumen. Vibriones rapidly form after emission.

If the cystitis arises from calculus, the appearances are the same, except that blood is in larger quantity, and is more frequently seen.

[1] Med. Gazette, 1851.

SECTION VII.

DISEASES OF THE PROSTATE.

Acute or chronic inflammation of the prostate is frequently accompanied with inflammation of the urethral mucous membrane; and the microscopic appearances of the urine are the same as in urethritis and cystitis. Sometimes prostatic cylinders are seen, and little albuminous masses, which have been detached. The thick, albuminous secretion which sometimes flows from the urethra, when efforts are made at stool, may also find its way into the urine.

Organic Disease of the Bladder.

Villous cancer, at a certain stage, is generally attended with much bleeding. Epithelium, pus, and granular cells are present in the urine in most cases, and sometimes some portion of the tumour becomes detached. If it be a fungoid growth, minute parts of vessels, or proliferating connective tissue, may be thrown off by slough, and appears in the urine; but this is, perhaps, not common, and frequently the urine presents no other signs than those of chronic cystitis.

SECTION VIII.

AFFECTIONS OF THE FEMALE GENITO-URINARY ORGANS.

The appearances in the urine from diseases of the bladder and ureters are similar to those in men. The frequent coexistence of leucorrhœa, however, with cystitis causes the appearance of vaginal epithelium and cells derived from rapid exfoliation, which have been so well described by Tyler Smith. A very large quantity of albumen is thus sometimes added to the urine, and, until after exploration of the vagina, it might be supposed that the albuminuria owned a renal origin. Sometimes little masses of albuminous substance, mixed up with epithelium-cells, are seen.

It is hardly necessary to mention that, in menorrhagia, some of the blood finds its way into the urine, with vaginal epithelium. In ordinary menstruation, blood also passes into the urine; but, with ordinary care, any mistake from this circumstance is impossible.

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